STATUS REPORT ON THE DISTRIBUTION AND ECOLOGY OF HARLEQUIN DUCKS IN BRITISH COLUMBIA

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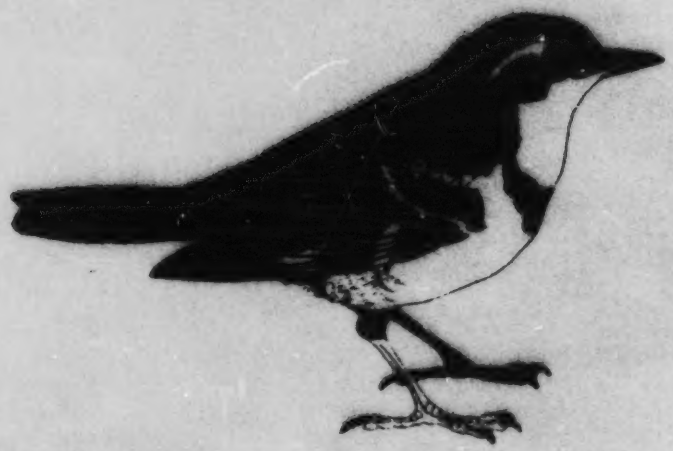

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Andre M. Breault
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ABSTRACT

Harlequin Ducks (*Histrionicus histrionicus*) breed discontinuously throughout the holarctic zone. Small populations are found in Greenland, Iceland and eastern North America, while a large population is found in the Pacific. Because of their remote breeding and wintering habitats, the ecology of Harlequin Ducks is poorly understood. No detailed information is available on the status of the species in British Columbia. This report 1) summarizes known information on breeding and wintering ecology of Harlequin Ducks throughout their range, 2) summarizes breeding and non-breeding distribution and abundance in British Columbia and 3) identifies management and research priorities necessary to the protection of the local population.

A literature search identified 220 studies on Harlequin Duck ecology. Key aspects of breeding and wintering ecology (e.g. movements, habitat use, diet, reproductive success and philopatry) are summarized.

Distribution and abundance in British Columbia was summarized from published and unpublished literature. We found 53 breeding records (4 nests and 49 unfledged broods), originating mostly from provincial and federal parks. Wintering birds were found throughout coastal British Columbia. Fifteen areas on the east coast of Vancouver Island and in the Queen Charlotte Islands were used by at least 100 wintering birds. Analyses of Christmas Bird Counts from 1975 to 1987 and bi-weekly estuarine surveys on Vancouver Island from 1973 to 1975 failed to detect yearly fluctuations in abundance of molting and wintering birds. The number of Harlequin Ducks breeding and wintering in British Columbia could not be estimated from available data.

We recommend 1) immediate surveys to determine size and distribution of local wintering populations, 2) immediate studies of distribution, productivity and habitat use by breeding individuals, 3) close monitoring and protection of important breeding and wintering sites and 4) studies of marked individuals to determine the origin of birds wintering in British Columbia.

RESUME

Le canard arlequin (*Histrionicus histrionicus*) niche de façon discontinue dans la zone holarctique. De petites populations se retrouvent au Groenland, en Islande et dans l'est de l'Amérique du Nord, tandis qu'une population importante se retrouve dans le Pacifique. Parce que les canards arlequins nichent et hivernent souvent dans des habitats inaccessibles, leur écologie est peu connue. Aucune information n'est présentement disponible sur le statut du canard arlequin en Colombie-Britannique. Ce rapport 1) résume les données disponibles sur l'écologie du canard arlequin sur les sites de nidification et d'hivernage, 2) résume la distribution et l'abondance en periode de nidification et d'hivernage et 3) identifie les priorités d'aménagement nécessaires à la protection de la population locale.

Un relevé de littérature a identifié 220 études couvrant l'écologie du canard arlequin. Nous présentons un sommaire des principaux aspects de l'écologie de l'espèce en période de nidification et d'hivernage (i.e. utilisation de l'habitat, diète, mouvements, succès reproducteur et philopatrie).

Nous avons regroupé l'information sur la distribution et l'abondance du canard arlequin en Colombie-Britannique à partir de recensements publiés et non-publiés. Nous avons trouvé 53 cas de nidification (4 nids et 49 couvées avec jeunes incapables de voler), provenant principalement de parcs provinciaux et fédéraux. Les canards arlequins hivernent dans toutes les régions côtières de la province. Quinze régions sur la côte est de l'Ile de Vancouver et sur les Iles de la Reine Charlotte ont de par le passé été utilisées par plus de 100 individus durant l'hiver. L'analyse de recensements de Noël de 1975 à 1988, de même que les recensements bi-mensuels sur l'Ile de Vancouver entre 1973 et 1975 n'ont pas permis de détecter des fluctuations dans l'abondance des populations hivernales. Le nombre d'individus nichant et hivernant en Colombie-Britannique n'a egalement pu être estimé à partir des données disponibles.

Nous recommandons 1) que des recensements visant à déterminer la taille et la distribution de la population hivernale en Colombie-Britannique soient immediatement conduits, 2) une étude immédiate de la distribution, la productivité et l'utilisation de l'habitat chez les individus reproducteurs, 3) une surveillance étroite et la protection des principaux sites d'hivernage et 4) l'utilisation d'oiseaux marqués afin de déterminer l'origine des individus hivernant en Colombie-Britannique.

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INTRODUCTION

This project was prompted by the precarious status of the eastern North American Harlequin Duck (*Histrionicus histrionicus*) population now designated "endangered" (Goudie 1989a; COSEWIC 1990) and the lack of information on distribution and status of Harlequin Ducks in British Columbia. Because effective management and conservation policies depend upon detailed knowledge of wintering and breeding requirements, we reviewed Harlequin Duck ecology and summarized available information on the distribution and status of breeders and non-breeders in British Columbia. Specifically, this report 1) presents the results of a literature search on the ecology of Harlequin Ducks, 2) summarizes data on distribution and abundance of breeding and non-breeding Harlequin Ducks in British Columbia and 3) reviews conservation needs and management priorities for the species. Each point will be covered in a separate chapter.

CHAPTER 1: LITERATURE SEARCH ON HARLEQUIN DUCK ECOLOGY

Introduction

The Harlequin Duck is the only species of duck in the Northern Hemisphere to live on fast-flowing rivers (Lazarus *et al.* 1979). In North America, most of its range lies within remote regions (Bellrose 1976). Nesting occurs along shores adjacent to turbulent mountain streams, while birds winter along coastal shores (Bellrose 1976; Palmer 1976). General accounts of Harlequin breeding and wintering ecology can be found in Delacour (1959), Johnsgard (1975), Palmer (1976), Bellrose (1976), Cramp and Simmons (1977) and Johnsgard (1979), but those accounts are based on a limited number of studies conducted in Iceland in the 1960's (e.g. Bengston 1966; 1970; 1972; Bengston and Ulfstrand 1971; Gudmundsson 1971 in Cramp and Simmons 1977) and 1970's (Lazarus *et al.* 1979). In this chapter, we 1) identify recent Harlequin Ducks studies and 2) summarize and update information on reproductive and non-reproductive biology.

Methods

1) Literature review

We conducted a literature review using the keywords "Harlequin Duck" and "*Histrionicus histrionicus*" in the following publications:

- Wildlife Review, vol. 168 (1978) to vol. 214 (1989)
- Biological Abstracts, Jan. 1988 to Nov. 1989
- Bibliography of British Columbia Ornithology, vols. 1 and 2 (Campbell *et al.* 1979; 1988)
- Dissertation Abstracts International, vol. 40 (1979) to vol. 49 (1989), under the headings "Agriculture - Forestry and Wildlife", "Ecology" and "Zoology"

All references from refereed journals and theses were compiled. For non-refereed sources, only articles with titles suggestive of general ecology information (i.e. more than distribution data only) were compiled. The literature cited section of selected papers was also searched for other references.

2) Summary of breeding and non-breeding ecology

Based on selected references from the above, we summarized the current state of knowledge on habitat selection, movements, densities, diet and reproductive behavior of breeding and wintering Harlequin Ducks.

Results

1) Literature search

We identified 220 studies covering breeding and non-breeding ecology of Harlequin Ducks. Those studies are listed in the Literature Cited section of this report.

2) Summary of breeding and non-breeding ecology

A) Breeding ecology

Two types of breeding populations have been studied: populations nesting in coastal environments [e.g. Iceland (Gudmunsson 1971; Bengston 1972) and Alaska (Dzinbal 1982)] and populations nesting inland [e.g. Montana (Kuchel 1977); Wyoming (Wallen 1987) and Idaho (Cassirer 1989; Cassirer and Groves 1989; Wallen and Groves 1988; 1989)]. Caution should be used when interpreting results from one type of breeding population to the other. Harlequin Ducks nesting on coastal streams frequently fed on the coast during nesting period (Dzinbal 1982), and absence of migration between wintering and breeding areas might affect physiological condition of breeding females, habitat use and reproductive behavior. Studies of coastal populations will be discussed separately from studies of inland populations.

There is no evidence of territoriality for Harlequin Ducks nesting on coastal streams in Alaska and Iceland (Dzinbal 1982; Bengston 1972), even though pairs in Idaho (Wallen and Groves 1988) and Montana (Kuchel 1977) showed mutual avoidance of adjacent pairs. Whether avoidance of neighboring pairs indicates true territoriality in inland populations or defense of mated females (Bengston 1972) is unknown. A detailed study of pre-nesting behavior in Iceland indicates that males strongly defend their mate but do not maintain territories (Inglis *et al.* 1989).

Nesting occurs on islands in Iceland (Bengston 1966; 1972); on beaver ponds, abandoned meanders and swift channels in Montana (Kuchel 1977), and on fast-flowing streams located away from human activity in Idaho and Wyoming (Wallen 1987; Wallen and Groves 1988; 1989; Cassirer and Groves 1989). A brood was successfully raised on a lake in Alaska (Dzinbal 1982) and adults have been observed on lakes in Iceland (Bengston 1966).

In Alaska, Harlequin Ducks breed primarily along the coast (Johnsgard 1975), and breeding records from the interior of Alaska are relatively uncommon (Gabrielson and Lincoln 1959). Coastal streams used by breeding individuals are primarily non-glacial, possibly because of low invertebrate populations and water turbidity (Dzinbal 1982). In Montana, 47% of the birds observed used canyon-type channels (Kuchel 1977). Stream gradient at

nesting locations is less than 1% in Idaho (Wallen and Groves 1989) and less than 3% in Wyoming (Wallen 1987). Log jams and overhanging vegetation seem important for cover (Kuchel 1977; Wallen and Groves 1988; 1989). On large rivers, mid-stream loafing sites such as islands or boulders offered security from disturbance (Wallen and Groves 1989). Nesting stream width varied from 7 to 50m in Idaho (Wallen and Groves 1989) and from 2 to 40m in Iceland (Bengston 1966; 1972).

Harlequins Ducks become sexually mature at 2 years of age (Kortright 1942). Duller plumage of year-old males and internal and external gonadal inspection of females seen on the breeding grounds in Iceland indicated that immature males and females do not regularly enter breeding areas (Bengston and Ulfstrand 1971), although some do in Iceland and Greenland (Bengston 1966; 1972). The proportion of immature individuals in breeding areas in North America is unknown.

From 15 to 62% of all females observed on the breeding grounds are non-breeders (see below), but definitions of non-breeders vary from study to study. Based on cloaca and ovary inspection of 36 females, 15-30% of females seen on breeding areas in Iceland did not attempt to breed (Bengston and Ulfstrand 1971). In Alaska, proportion of non-breeders (females not tending broods and without a brood patch in late summer) varied from 47 to 50% (Dzinbal 1982). In Wyoming, proportion of non-breeding females (defined as females without broods) was 62% of all females seen in breeding areas (Wallen 1987). No information is available as to the causes of the high ratio of non-breeders on breeding grounds.

Breeding individuals arrived to breeding areas in Idaho and Montana in late April and early May (Kuchel 1977; Wallen and Groves 1988; 1989; Cassirer and Groves 1989) and at the end of April and early May in Iceland (Bengston 1966; 1972). In Iceland, the first few days after arrival to breeding areas are spent at common loafing spots, where up to 40-50 individuals can be observed simultaneously (Bengston 1966).

Mean nesting densities in Idaho ranged from 0.15 to 0.25 pair/km of stream (Cassirer and Groves 1989), much lower than the 1.3 pair/km in Iceland (range 0.2 to 7.1 pair/km) (Bengston 1972); Glacier National Park (0.67 to 0.91 pair/km) (Kuchel 1977); Grand Teton National Park (0.89 pair/km) (Wallen 1987) and Alaska (0.56 to 0.77 pair/km) (Dzinbal 1982). Lower densities in Idaho might be related to high levels of human activities (Wallen and Groves 1989). The highest reported breeding densities are in mountain streams of eastern Siberia with 11 pairs on 11km of river and 20-30 broods in 25km (Kistschinsky 1968 cited in Bengston 1972) and an average 10.5 pairs on 418m of river in Iceland (Inglis *et al.* 1989).

Breeding adults are usually paired prior to arrival at nesting areas (Kuchel 1977; Lazarus *et al.* 1979; Dzinbal 1982; Wallen 1987), but there is a surplus of males on breeding grounds (Bengston 1966; 1972; Inglis *et al.* 1989). In Iceland, females alone choose the nest site (Bengston 1966). Nests are located close to water, in dense cover, on inaccessible islands (Bengston 1966; Lazarus *et al.* 1979). In North America, the species had been reported to nest in tree cavities (Delacour 1959), but this has been denied by later authors (Palmer 1976).

In Montana, Wyoming, Idaho and Alaska, laying takes place from mid-May to mid-June (Kuchel 1977; Cassirer and Groves 1989; Wallen and Groves 1988; 1989; Dzinbal 1982), similar to breeding chronology in Iceland (Bengston 1966; 1972). In Iceland, reported mean clutch sizes are 5 to 7 eggs (Gudmundsson 1961 in Cramp and Simmons 1977), 5.5 (Bengston 1966) and 5.7 eggs (Bengston 1972), while no information is available from studies of breeding birds in North America. Harlequin egg collection was a common practice in Iceland in the early 1960's and might have affected Icelandic estimates of clutch sizes (Bengston 1966). Conflicting data is available on incubation period: 27-29 days in Iceland (Bengston 1966; 1972), 28-29 days in North America (Todd 1979) and 30 to 34 days in incubators (see Bengston 1966).

Hatching occured in the last 2 weeks of June in Idaho (Wallen and Groves 1988; 1989; Cassirer and Groves 1989); in the first week of July in Montana (Kuchel 1977); from 20 July to 6 August in Wyoming (Wallen 1987); from 3 to 15 July in Alaska (Dzinbal 1982) and in early July in Iceland (Bengston 1966). Number of young at hatching ranges from 3 to 10 per clutch (Bengston 1966; 1972; Kuchel 1977; Wallen 1987). An average of 5.3 eggs hatched per successful nest in Iceland, indicating that at least 80% of the eggs hatch (Bengston 1972). In a 3-year study in Montana, juvenile survival to fledging varied from 18% to 83%, with all chick mortality occurring in the first 3 weeks following hatching (Kuchel 1977).

Young broods in Idaho, Montana and Wyoming were found in upper section of streams with dense shoreline vegetation and slower water, and moved downstream as the breeding season progressed (Kuchel 1977; Wallen 1987; Cassirer and Groves 1989). Downstream movement with older broods has also been reported for Iceland (Bengston 1966). Cramp and Simmons (1977) mention that broods do not amalgamate, but brood amalgamation has been observed in Iceland (Bengston 1966). No evidence of brood amalgamation is available for North America.

Extensive variations in fledging time have been observed across studies: 40 days (Faber 1822 in Bengston 1966) and 42 days in Iceland (Bengston 1972); 42 days in Wyoming (Wallen 1987); 55 days in Montana (Kuchel 1977); 62 days in Idaho (Cassirer and Groves

1989) and from 60 to 70 days in Iceland (Gudmundsson 1971 in Cramp and Simmons 1977).

Estimates of brood size at fledging were 2.63 young per pair for Alaska (n= 8 broods) (Dzinbal 1982); 3.88 in Montana (n=8) (Kuchel 1977); 4.3 (n=6) and 4.67 (n=3) for Idaho (respectively Wallen and Groves 1989 and Cassirer and Groves 1989) and 5.4 in Wyoming (n=15) (Wallen 1987). Lower productivity in Alaska and Montana was correlated to greater precipitation and stream discharge (Dzinbal 1982; Kuchel 1977), but was associated with lower benthic standing crop in Iceland (Bengston and Ulfstrand 1971). Sample sizes were however small in all studies.

No evidence of predation on young or adults is available for North America, but Raven (*Corvus corax*), Mink (*Mustela vison*), Arctic Skua (*Stercocarius parasiticus*) and Arctic Fox (*Alopex lagopus*) are predators in Iceland (Bengston 1966; 1972).

Diet consists of benthic insects and drifting and surface invertebrates (Michael and Michael 1922; Cottam 1939; Bengston 1966; 1972; Bengston and Ulfstrand 1971; Gudmunsson 1961 in Cramp and Simmons 1977; Kuchel 1977; Wallen 1987), with stoneflies comprising 90% of the stomach content of 2 birds collected in Wyoming (Cottam 1939). Analyses of a gizzard and fecal material in Wyoming revealed that mayfly and stonefly larvae were an important part of the Harlequin Duck diet (Wallen 1987). In Alaska, Harlequin Ducks fed primarily on marine invertebrates in the intertidal area of creeks in early summer (Dzinbal 1982). Incubating females fed at the outflow of some streams, but moved upstream in July to feed on drifting salmon roe (Dzinbal 1982). Harlequin Ducks apparently do not feed at night (Johnsgard 1975; Dzinbal 1982). Harlequin ducklings take relatively more food from the surface than adults (Bengston 1972).

In Idaho, males left breeding areas once females started to incubate (Cassirer 1989), but adult females and juveniles stayed until mid to late August (Wallen and Groves 1988; 1989). In Iceland, males departed breeding grounds by the end of June and early July (Bengston 1966). Most Harlequin Ducks had left Idaho by the end of August (Wallen and Groves 1989), but there are some reports of broods and/or adults in Idaho, Montana and Wyoming in September (respectively Cassirer and Groves 1989; Kuchel 1977; Wallen 1987). Variations in departure dates are presumed to be related to breeding chronology, which is in turn presumed to be affected by timing of spring snow melt (Wallen 1987).

Studies of individually-marked birds revealed that adults and yearlings are highly philopatric to breeding areas (Kuchel 1977; Wallen 1987). Females and fist-time breeding females returned to natal areas in Montana (Kuchel 1977) and Idaho on successive years (Wallen and Groves 1988). Site and mate fidelity has been observed in Wyoming (Wallen 1987), Idaho (Cassirer and Groves 1989) and

Iceland (Bengston 1966; 1972). However, marking techniques sometimes affected individuals. Three females on which radio-transmitters were installed in Wyoming did not nest on the year following capture (Wallen 1987), while lower productivity was observed on birds marked with patagial markers in Alaska (Dzinbal 1982).

Morphological data (weight, total length, culmen, middle toe, tarsus and wing length) on breeding individuals is available for Montana (Kuchel 1977) and Wyoming (Wallen 1987). Males are on average heavier than females (males=602g, n=10; females=539g, n=15), with paired males weighing between 640 and 650g and bachelor drakes weighing less than 600g (Wallen 1987).

2) Wintering ecology

During the non-breeding season, Harlequin Ducks are highly gregarious (Bengston 1966). In Iceland, males congregate in post-breeding flocks (clubs) on the breeding grounds in mid-June and start molting (Bengston 1966). These groups of males leave for the coast in late-June and early-July (Bengston 1966; 1972), possibly to seek better food resources and safer habitats for their flightless period. In Iceland, female Harlequins do not begin molt until the broods have been led to sea in August or September (Gudmundsson 1971 in Kuchel 1977; Cramp and Simmons 1977). There are reports of a flightless adult female and a group of molting drakes in Wyoming (Wallen 1987), but those may be isolated cases. Individual pairs can be observed on the wintering grounds from October to June, with a peak abundance in February to April (Fleischner 1983).

Male-biased sex-ratios have been reported in various studies of wintering Harlequin Ducks (e.g. Bengston 1972; Fleishner 1983; Dzinbal 1972; Savard 1989). Potential explanations for biased sex-ratios include differential timing of migration between individuals of different age and sex, differences in predation and hunting pressure and greater mortality incurred by breeding females.

Wintering Harlequin Ducks prefer exposed coastal areas (Cottam 1939; Johnsgard 1975; Palmer 1976; Cramp and Simmons 1977; Dzinbal 1982; Hirsch 1980; Goudie and Ankney 1986; 1988). In Iceland, Harlequins winter on exposed coast around the island (Gudmundsson 1961 and 1971 in Cramp and Simmons 1977; Bengston 1966). In the Puget Sound area, wintering habitats include shallow eelgrass and kelp communities (Hirsch 1980) and rocky intertidal and cobble beach areas (Fleishner 1983), even though use of calmer areas such as sheltered coves has also been reported (Fleischner 1983, Hirsch 1980). In Alaska, sheltered streams are used in July and early August (Dzinbal 1982).

In Iceland, diet of 8 wintering Harlequins consisted mostly of crustaceans (isopods, amphipods and small crabs) (Gudmundsson 1971 in Cramp and Simmons 1977). Stomach analyses of North American individuals collected at sea from January to September (n=63) indicated a diet of 57% crustaceans (46% of which crabs) and 25% molluscs (mostly univalve molluscs) (Cottam 1939). Stomach analyses from Maine (n=9) identified mostly crustaceans and molluscs (Palmer 1949 in Dzinbal 1982). In Washington State, wintering Harlequin Ducks (n=23) fed mostly on snails, limpets, crabs and chitons (Gaines and Fitzner 1987) and were observed feeding on crabs and small fish (Fleischner 1983). Birds collected near Comox, British Columbia fed almost exclusively on *Hemigrapsus* crabs (Cottam 1939), while birds collected in March and November on Cortes and Saltspring Islands (n=54) had fed on snails, limpets, fish eggs, crabs, chitons, algae and bivalves (Vermeer 1983). In Puget Sound, rough and calm sea condition did not affect foraging rates, but more foraging took place at low than at high tide (Fleishner 1983).

Discussion

Only six major studies are available on the reproductive ecology of Harlequin Ducks: Kuchel 1977; Dzinbal 1982; Bengston 1966; 1972; Cassirer and Groves 1989 and Wallen 1977. Those studies all point at the importance of pristine breeding habitat away from human disturbance. Nesting usually takes place in relatively undisturbed, low-gradient mountain streams with abundant riparian vegetation, with log jams and overhanging vegetation used as cover. Areas frequented by humans are usually avoided but human activities can be tolerated if dense cover along streams can shield them from disturbance (Kuchel 1977).

Food availability is thought to determine choice and use of breeding habitat (Bengston 1966, 1972, Bengston and Ulfstrand 1971, Kuchel 1977). Harlequin Ducks nest in areas of relatively low mean benthic animal standing crop and low production rate (Ulfstrand 1968, Bengston and Ulfstrand 1971), which is probably responsible for observed low breeding densities (Bengston 1972). Only in places of higher food abundance are densities markedly higher (Bengston 1972). Observed hatching periods appear to coincide with periods of peak food abundance (Bengston 1972). Furthermore, small clutch size, a long incubation period, a short fledging time and early male departures from breeding areas may all be regarded as adaptations to food-limited environments (Bengston 1972).

Mate fidelity observed in a few studies (Bengston 1966; 1972; Wallen 1987; Cassirer and Groves 1989) may be more common than previously believed. Studies on Barrow's Goldeneye (*Bucephala islandica*) indicated high mate fidelity (Savard 1985) and high breeding and wintering philopatry of individuals and pairs (Savard

1988a; Savard and Eadie 1989). Available data on Harlequin Ducks suggest similar behavior.

Harlequin Ducks appear to have low reproductive success (Kuchel 1977; Dzinbal 1982; Wallen 1987; Cassirer and Groves 1989; Wallen and Groves 1989), but this might be confounded by difficulties in conducting surveys. Factors shown to affect productivity include high spring runoffs, that either destroy nests or create stream conditions too harsh for young birds (Dzinbal 1982), and flooding resulting from torrential rainstorms, which reduces young survival (Wallen 1987).

The chronology of migrations to and from breeding areas is reasonably well established, but most other aspects of the ecology of Harlequin Ducks are still poorly understood. Limited or conflicting data is available on incubation time, fledging period and molting ecology of the species. Available studies of coastal and inland breeding populations provide insufficient understanding of the ecology in each habitat. For example, low productivity typical of coastal streams may be offset by 1) seasonal influx of anadromous fish (e.g. salmon) or 2) daily flights to the sea.

Even though there has been substantial increases in the understanding of Harlequin Duck breeding and wintering ecology since the studies conducted in Iceland in the 1960's and 1970's, total information available amounts to very little. No studies have been conducted yet in British Columbia.

CHAPTER 2: DISTRIBUTION AND ABUNDANCE OF HARLEQUIN DUCKS IN BRITISH COLUMBIA

Introduction

1) Worldwide distribution

The Harlequin Duck is a monotypic species found in scattered, more or less disjunct units across the Nearctic and Palearctic zones (Palmer 1975; Cramp and Simmons 1977). Four separate populations are recognized: 1) a small eastern North American population (<500 pairs); 2) an Icelandic population (5000 breeding pairs); 3) a Greenland population similar in size to the Icelandic population and a Pacific (Asia and northwestern America) population of more than 1 million individuals (Goudie 1989a).

Little information is available on the status of each of the above populations. The population in Eastern North America is thought to have numbered in the low thousands prior to 1940, but only approximately 650-700 individuals currently winter in the area (Vickery 1988; Goudie 1989a;b). A recent review on the status of the eastern population by Goudie (1989a) has stressed the threatened status of that population, hunted until a few years ago. Icelandic Harlequin Ducks are found within the young volcanic belt that stretches from NE to SW Iceland and in NW Iceland (Bengston 1972). They are not hunted in Iceland, and their numbers have remained stable or slightly increased from 1966 to 1970 (Bengston 1972). Harlequin Ducks are protected in Greenland (Salomonsen 1950) but no extensive studies have yet been conducted on this population.

No precise information is available on the size of the Pacific population, but estimates at different locations indicate high numbers. Spring and fall counts on the Aleutian Islands National Wildlife Refuge alone have accounted for nearly 1 million individuals (Bellrose 1976), which probably includes both North American and Asian birds (Johnsgard 1979). In western North America, Harlequin Ducks breed from Alaska and the Yukon south through the western mountains to central California and Wyoming (Palmer 1975; Bellrose 1976; Johnsgard 1979).

2) Distribution in British Columbia

There are an estimated 4,000 to 8,000 breeding pairs of Harlequin Ducks in British Columbia (Bellrose 1976). The species is considered a widespread breeder in the province, with wintering population estimates of up to the high 10,000's (Campbell *et al.* 1990). Unfortunately the precision and accuracy of these estimates are unknown and they should be taken cautiously as they are derived from scant information.

Limited information is available on distribution and abundance of breeding, molting and wintering birds in British Columbia (but see Savard 1988b; 1989; Campbell *et al.* 1990 for winter

distribution and fluctuations in abundance in the Strait of Georgia). In this chapter, we identify and review available information on breeding and wintering distribution and abundance of Harlequin Ducks in British Columbia.

Methods

A) Breeding distribution in British Columbia

We searched the Royal British Columbia Museum Nest Record Scheme (BCNRS) and unpublished surveys for breeding records. Breeding records were classified as confirmed or unconfirmed. Confirmed breeding records were records for which there were observations of either 1) nests or unfledged young, 2) broods prior to 1 August or 3) broods of at least 8 young during the first week of August. Broods seen prior to 1 August were considered unfledged because hatching takes place in mid June, and fledging occurs after a minimum of 6 weeks (see chapter 1). Large broods in early August were presumed to be late or replacement clutches, as overall reproductive success in Harlequin Ducks is low (see chapter 1). Other observations of broods in August and September were treated as unconfirmed breeding records, because young might have been flight-capable and en route for wintering areas. Sightings of pairs or individuals during the breeding season were not treated as breeding records.

For each breeding record, we recorded location (1:50,000 scale topographic map number and name of water body), number of young seen, date and altitude (as indicated in original records or read from 1:50,000 topo maps). Records available through the BCNRS are cited as museum records, irrespective of their initial origin. Records from other sources are presented with either a publication reference or the name the contributor.

Breeding densities were derived from a helicopter survey conducted by Utah Mines Limited on Carbon Creek, Peace River District (Fig. 2.1) on 14 May 1977. Carbon Creek was flown at 30-60m from Willinston Lake to the confluence of Carbon Creek and the largest creek flowing from Beattie Mountain, for a total distance of 19.5km. All Harlequin Ducks seen on the creek were presumed to be breeders. Single individuals of opposite sexes less than or 1km apart were presumed to form a single pair, while they were treated as separate pairs when separated by more than 1km.

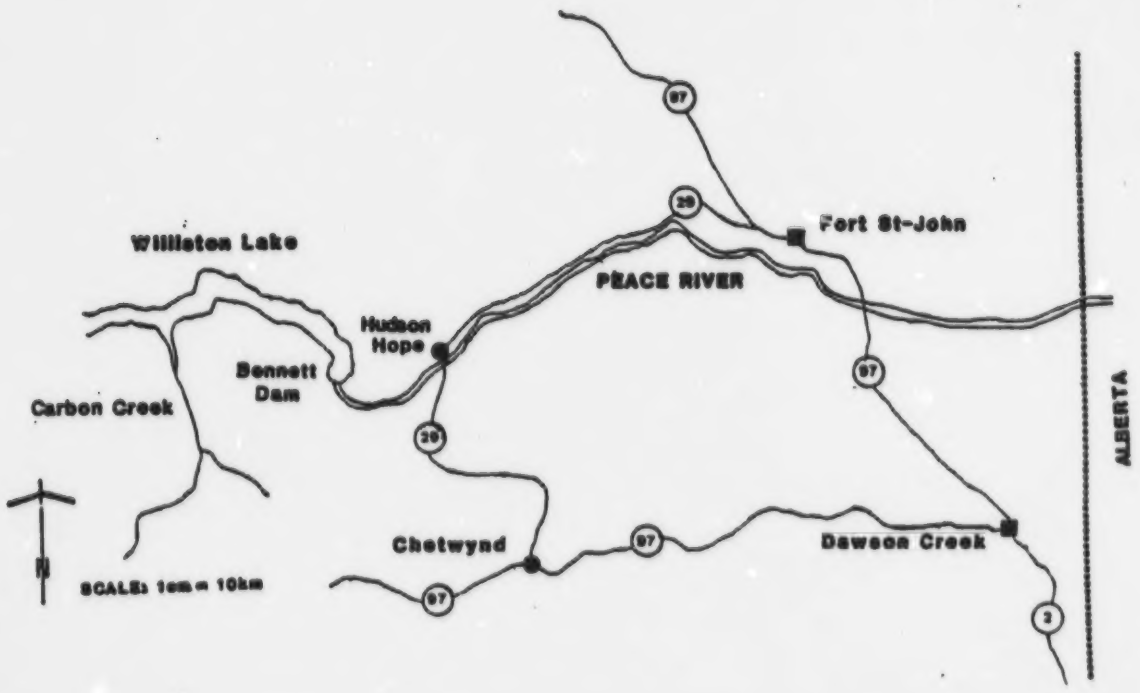

Figure 2.1 Location of Carbon Creek, Peace River District.

B) Molting and wintering distribution

We determined molting and wintering distribution from sightings from the Royal British Columbia vertebrate sightings cards, from published studies and from the following sources:

- Coastal mid-winter waterfowl surveys (from ground, air and boat) conducted by federal and provincial agencies or by private consultants prior to and including 1980.

- Weekly waterbird counts in the Comox area conducted by the Comox-Strathcona Natural History Society in 1980 and 1981 (Canadian Wildlife Service unpublished data).

- Unpublished Canadian Wildlife Service surveys from 1973 to 1975 of waterbirds found in estuaries on the east coast of Vancouver Island.

- Canadian Wildlife Service helicopter surveys of waterbirds around Tofino conducted from 11 January to 2 February 1989 (Rodway *et al.* 1989).

- Canadian Wildlife Service boat and ground surveys on the east coast of Moresby Island conducted from April to June, 1982 to 1986 (Rodway *et al.* 1988).

- Canadian Wildlife Service aerial surveys in Dixon entrance, Hecate strait and Chatham Sound in 1977 and 1978 (Savard 1978 a, b, c, d and e).

- Christmas Bird Counts in coastal British Columbia from 1958 to 1988.

Coastal British Columbia was divided into 79 regions (see Figure 2.2a, b, c). Records were compiled separately for each region and were used to determine the maximum number of Harlequin Ducks seen between September and April. Because individuals were rarely sexed during surveys, only total numbers are presented. Sightings from sources other than museum cards are presented in the appendices, with midwinter flight inventories in Appendix 1 and all other sightings pooled in Appendix 2. Sites or areas known to be used by at least 100 Harlequin Ducks were noted separately.

C) Seasonal abundance in coastal British Columbia

Seasonal fluctuations in abundance were studied from 47 ground surveys conducted on 7 adjacent zones on the east coast of Vancouver Island from Willemar Bluff to Deep Bay (see Figure 2.3) between 11 October 1980 and 10 October 1981. Raw data for each zone is presented in Appendix 3. We totalled the number of

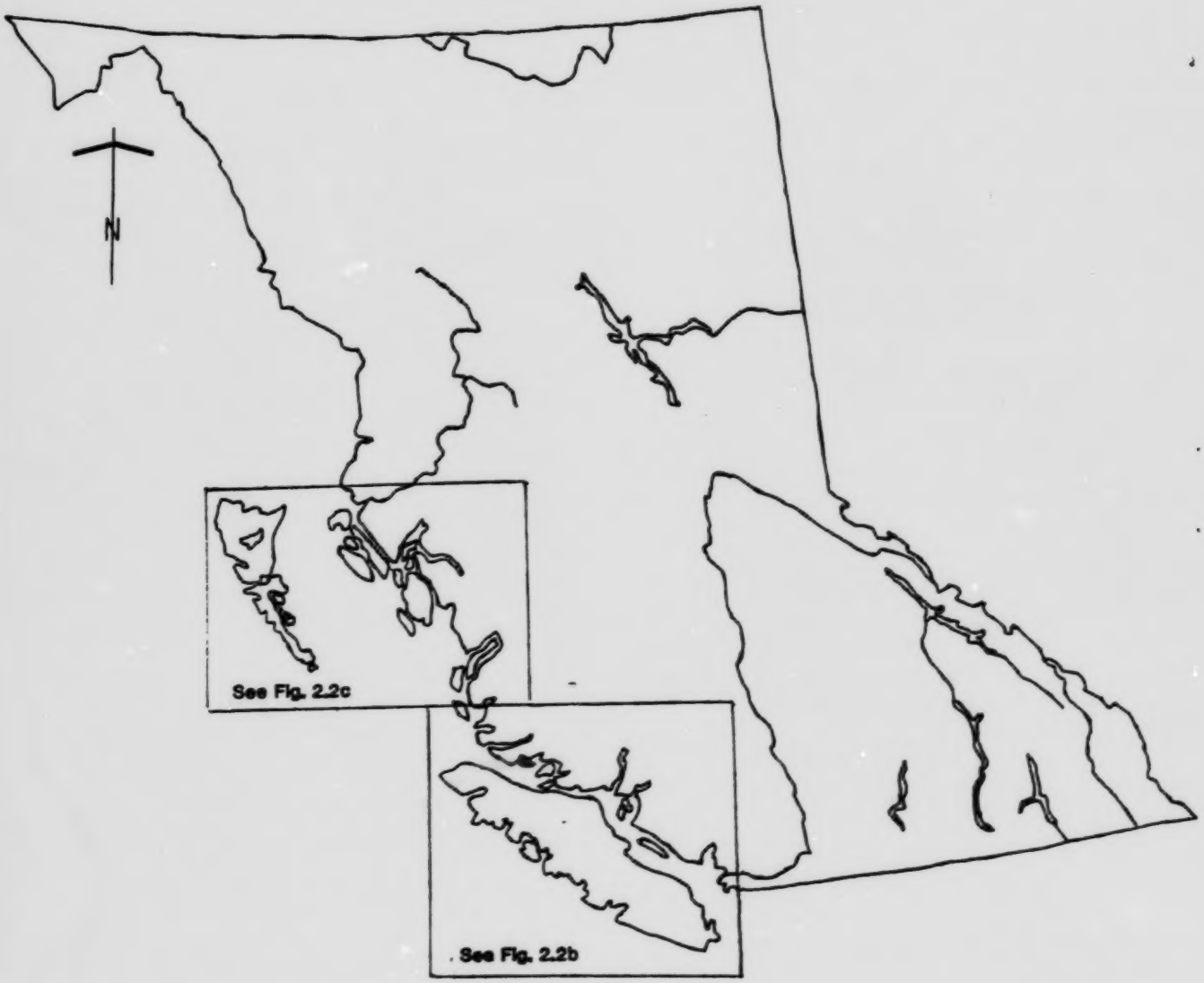

Figure 2.2a. Areas used to study molting and wintering distribution of Harlequin Ducks in coastal British Columbia.

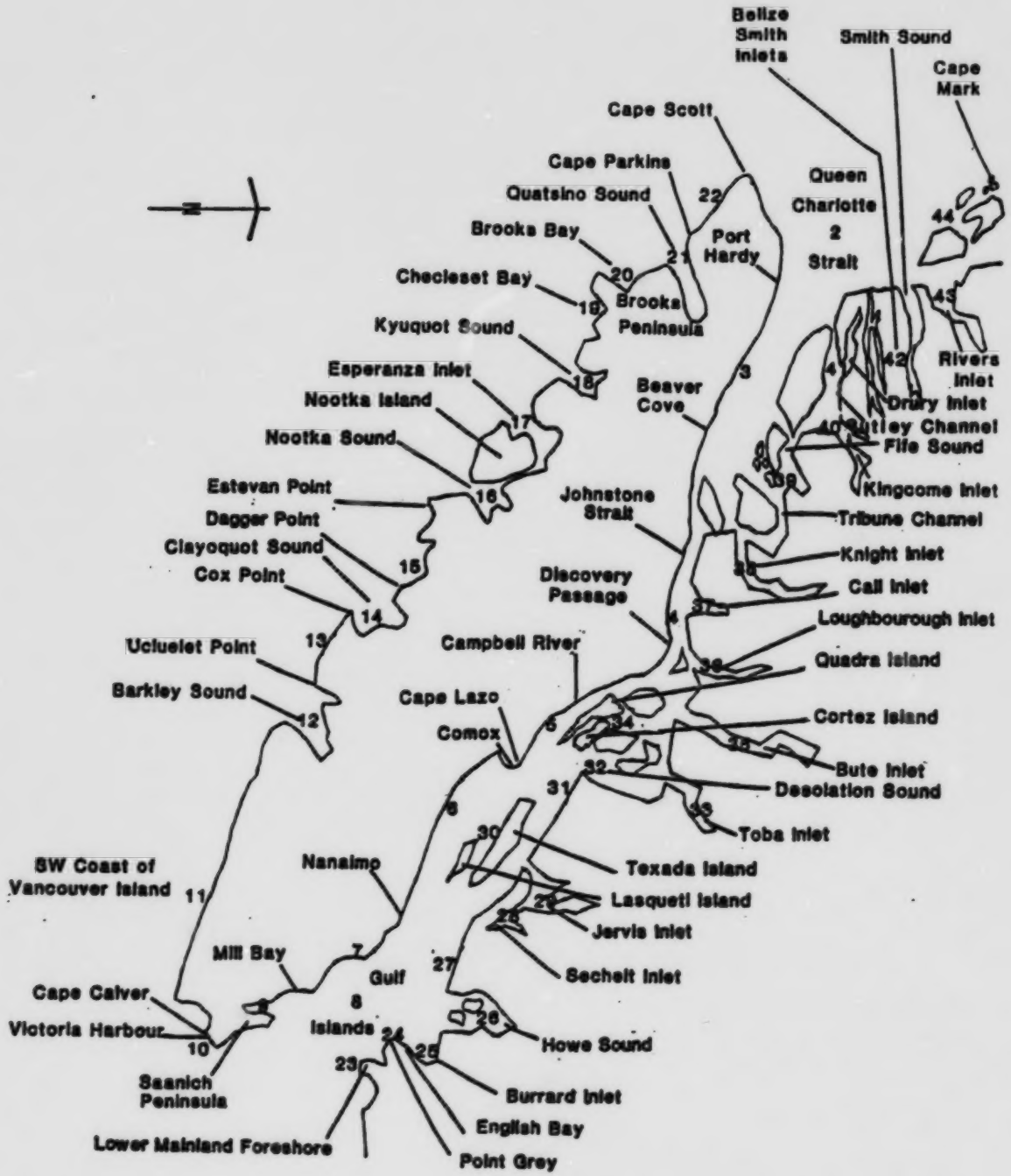

Figure 2.2b. Areas used to study molting and wintering distribution of Harlequin Ducks in southern coastal British Columbia.

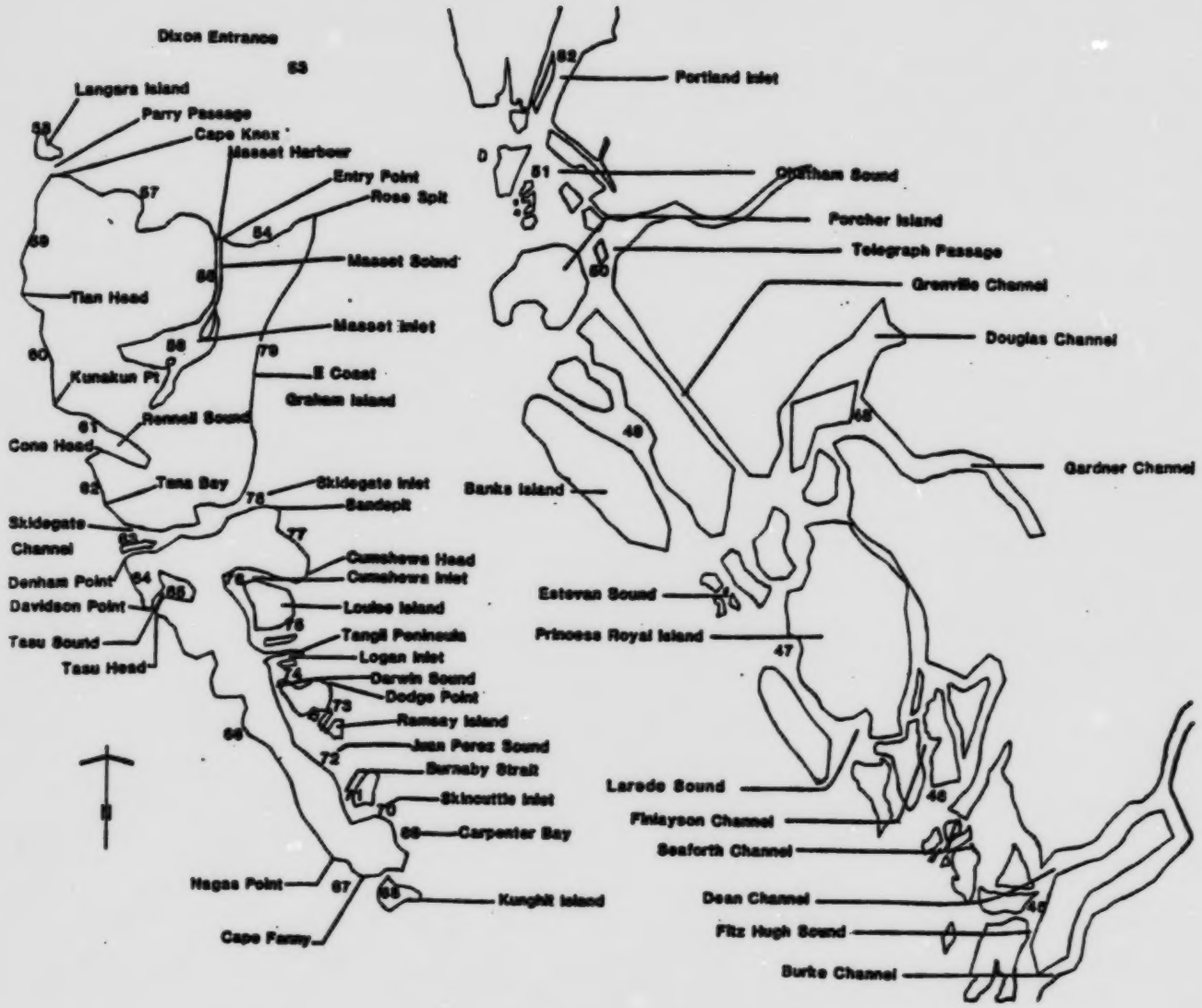

Figure 2.2c. Areas used to study molting and wintering distribution of Harlequin Ducks in northern coastal British Columbia.

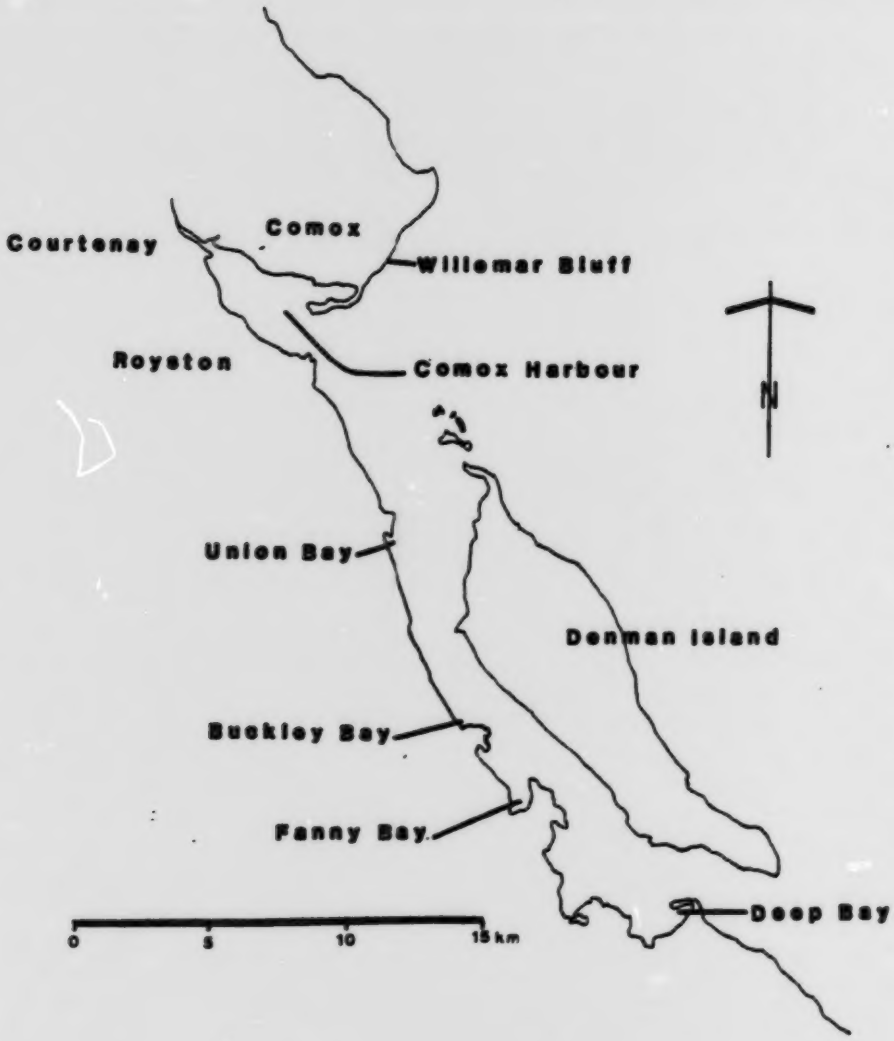

Figure 2.3. Area used to study seasonal abundance of Harlequin Ducks in Coastal British Columbia

Harlequins seen on surveys covering a minimum of 6 of the 7 zones (n=39 surveys). Missing data were replaced by the average of the previous and following surveys, except for Zone 5, not surveyed between 25 April and 18 July, for which we used the sum of the remaining 6 zones.

D) Annual fluctuations in abundance

We used selected Christmas Bird Counts to determine annual fluctuations in abundance. We compiled the total number of Harlequin Ducks seen over 8 areas (Comox, Deep Bay, Ladner, Nanaimo, Pender Islands, Vancouver, Victoria and White Rock) in 1976, 1977, and from 1979 to 1988 (12 years) (raw data in Appendix 4). Those areas were selected because they are used by the largest numbers of Harlequins and because data was available for all areas for those 12 years.

Christmas Bird Counts were also used to determine whether fluctuations in abundance were correlated across areas. For each area, the 12 counts (1976, 1977 and 1979 to 1988) were ranked according to the number of Harlequin Ducks observed. We compared ranking across areas with a Friedman 2-way ANOVA (SYSTAT software) (Wilkinson 1989), testing whether there are significant differences in ranking across areas. High ranking correlations would indicate that all areas are subject to comparable trends in fluctuations in abundance, in which case total surveys could be used as indicators of overall wintering abundance. Conversely, low correlations in ranking would indicate regional differences in population dynamics, raising the possibility that Harlequins move from area to area from year to year, in which case Christmas Bird Counts cannot be used to track yearly fluctuations in abundance.

Results

A) Breeding distribution

We identified 37 confirmed and 16 unconfirmed breeding records for British Columbia (See respectively Appendix 5 and Appendix 6). Breeding records were found for both coastal and inland British Columbia (Fig. 2.4), at altitudes ranging from sea level up to 2175m. Nineteen out of 53 records originated from ecological reserves or provincial and national parks

By order of importance, breeding records were obtained for inland streams/rivers (70%); lakes (17%); coastal islands and mainland coast (11%) and unknown (2%) (Table 2.1). No records were obtained for coastal streams and rivers. Of particular interest are records from a glacial lake in the Purcell Mountains and from a glacial stream near Berg Lake. Multiple breeding records are

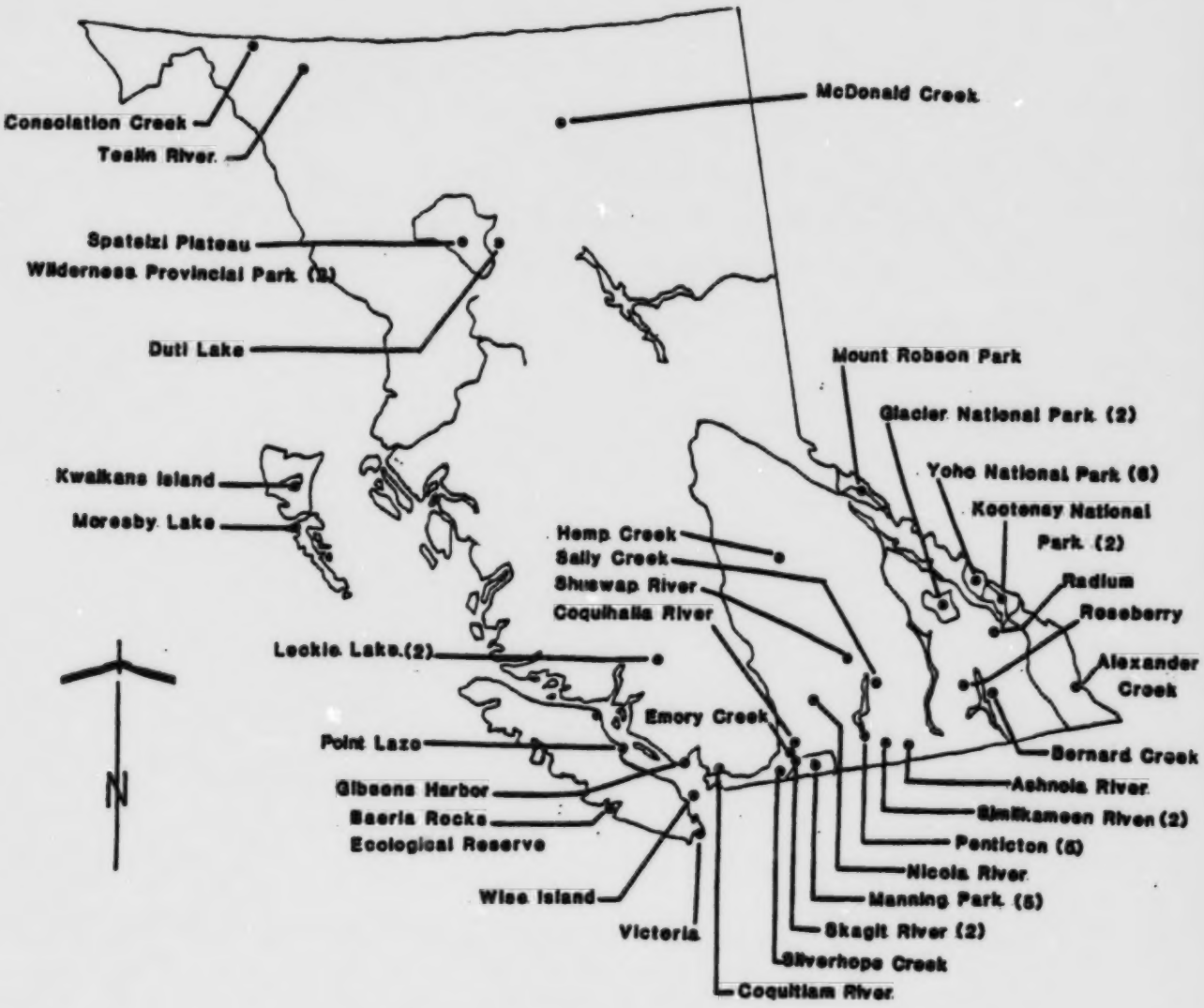

Figure 2.4. Distribution of Harlequin Duck breeding records in British Columbia.

Table 2.1. Distribution of Harlequin Duck breeding records in different habitats.[1]

NESTING HABITAT	NUMBER OF LOCATIONS	NUMBER OF RECORDS	PERCENTAGE OF RECORDS
Inland streams and rivers	29	37	70%
Lake	7	9	17%
Coastal islands and mainland coast	6	6	11%
Unknown	1	1	2%
Coastal streams and rivers	0	0	0%
TOTAL	43	53	100%

[1] Derived from both confirmed and unconfirmed breeding records.

available for only 5 water bodies in British Columbia: the Similkameen River (n=4); Shingle Creek (n=3); the Sumallo River (n=3); Lake O'Hara (n=3) and the Sumallo River (n=2) (Appendices 5 and 6).

In the Carbon Creek area, 10 pairs were localized over 19.5km of river, for a mean density of 0.51 pair/km of river.

B) Molting and wintering distribution and abundance

Wintering or molting Harlequin Ducks were observed throughout coastal British Columbia (Figure 2.5a, b). Areas with surveys of at least 100 individuals were located mostly in Georgia Strait (Figure 2.6), and some were found along the northern coast and in the Queen Charlotte Islands (see complete list in Appendix 7). Lower abundance in remote coastal areas might reflect a lack of surveys rather than an absence of Harlequin Ducks in those areas.

The sum of the maximum number of wintering Harlequin Ducks seen in each zone indicated the presence of at least 6186 individuals wintering along the coast. Because few surveys were available for most zones, and because most surveys covered only a fraction of each zone, this value is undoubtedly an underestimate of true wintering population size.

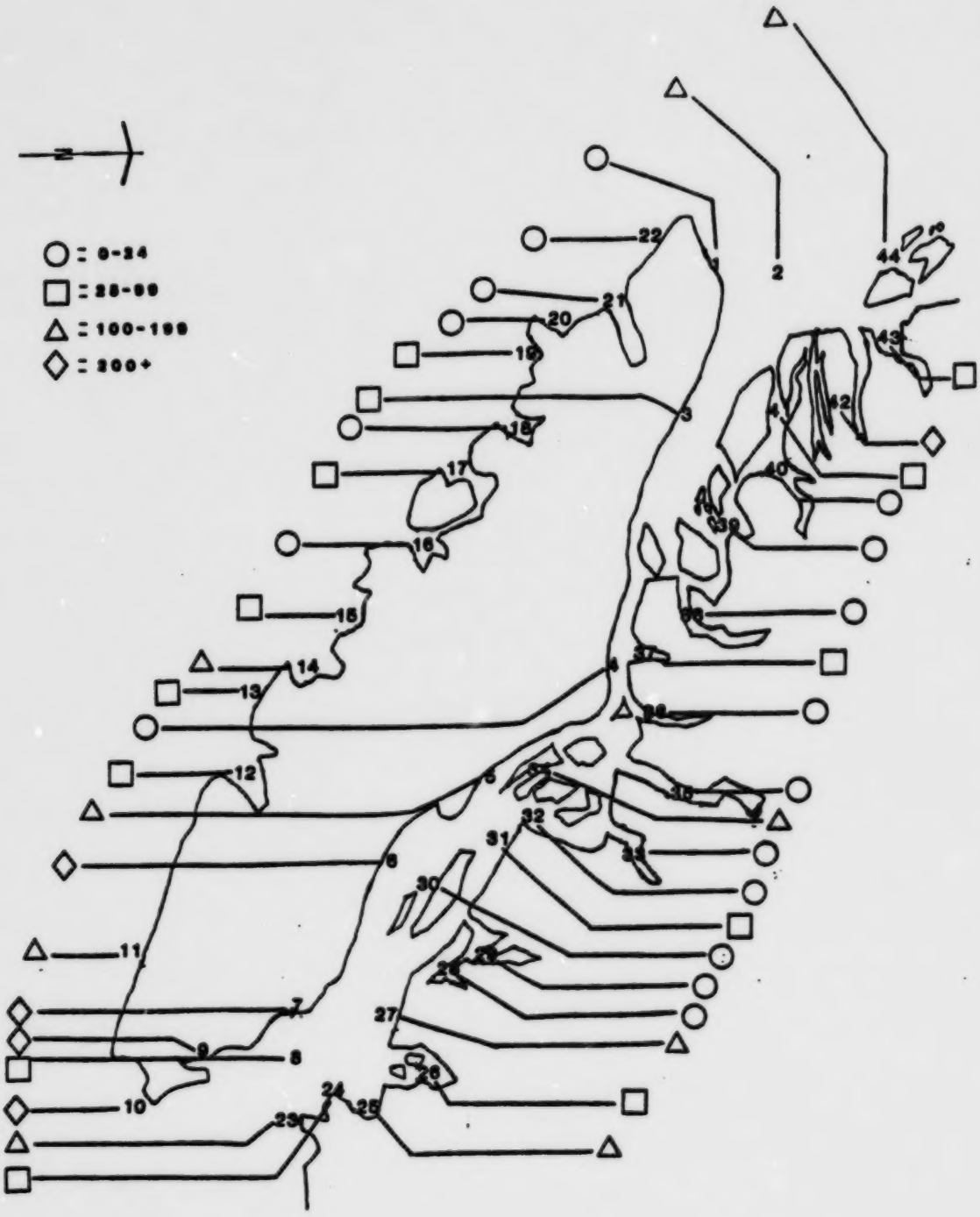

Figure 2.5a. Maximum number of wintering/molting Harlequin Ducks observed in southern coastal British Columbia

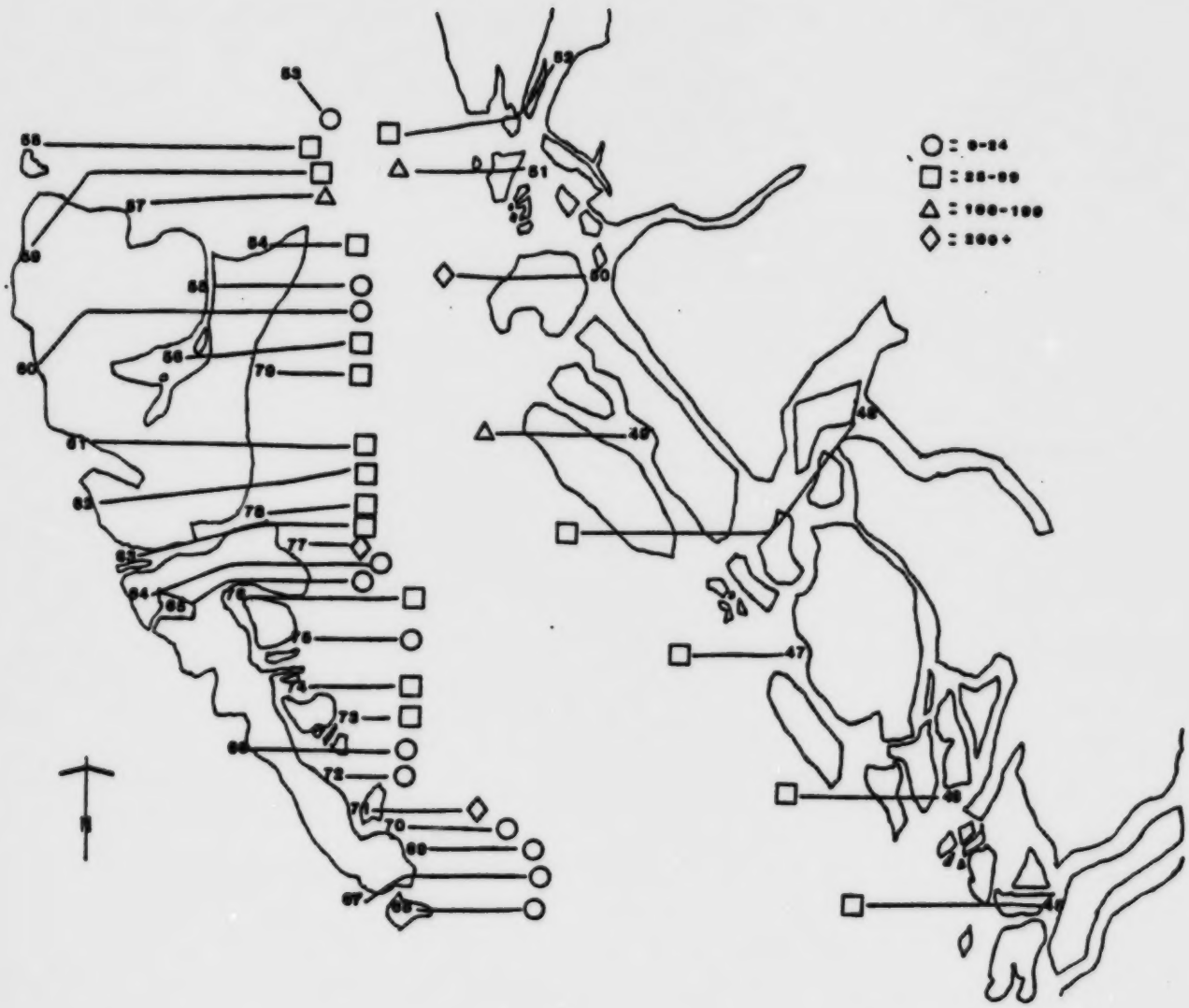

Figure 2.5b. Maximum number of wintering/molting Harlequin Ducks observed in northern coastal British Columbia

Figure 2.6. Sites at which more than 100 Harlequin Ducks have been observed.

C) Seasonal abundance of Harlequin Ducks

Harlequin Ducks were observed every month of the year in the Comox area (Figure 2.7). Departures from the wintering area to the breeding grounds occurred in 2 peaks throughout April, May and June: a peak in late March-early April and a peak in the third week of May. Few individuals were observed in July and August. Return to the wintering area occurred throughout September, indicating that the Comox area is not used by molting individuals. The number of wintering birds fluctuated widely across fall and winter, with peak abundance observed on 28 March 1980.

D) Annual fluctuations in Harlequin Duck abundance

Results from Christmas Bird Counts conducted in 1976, 1977 and from 1979 to 1988 are presented in Appendix 4. Harlequin Duck numbers peaked in 1983 (1505 individuals) and were minimum in 1987 (658 individuals), but extensive variations were observed between years (Figure 2.8).

A Friedman 2-way ANOVA failed to reveal differences in the pattern of fluctuations in abundance across years between southern Georgia Strait areas (Friedman statistic=15.266, Kendall coefficient of concordance=0.218, p=0.12). This lack of differences in relative abundance across years suggests that each region experiences similar fluctuations in Harlequin Duck abundance, and that Christmas Bird Counts can be used to detect annual variations in populations wintering in southern Georgia Strait.

Discussion

The number of breeding records available for British Columbia is limited and does not allow a better estimate of overall breeding distribution and abundance than the one in Bellrose (1976) and Campbell *et al.* (1990). Most available breeding records come from heavily used and easily accessible areas (i.e. national and provincial parks, Princeton area), although breeding also takes place in remote areas. Nesting requirements in British Columbia appear flexible, ranging from coastal islands and mainland coast to alpine and glacial lakes and rivers.

Because Harlequin Ducks nest primarily in coastal streams in Alaska (Johnsgard 1975), nesting in short coastal creeks is believed to contribute substantially to annual Harlequin Duck production (Dzinbal 1982). While available information shows that Harlequin Ducks are both coastal and interior breeders in British Columbia, no records have been found for coastal streams and rivers. The relative importance of coastal and interior breeding populations in British Columbia remains unknown.

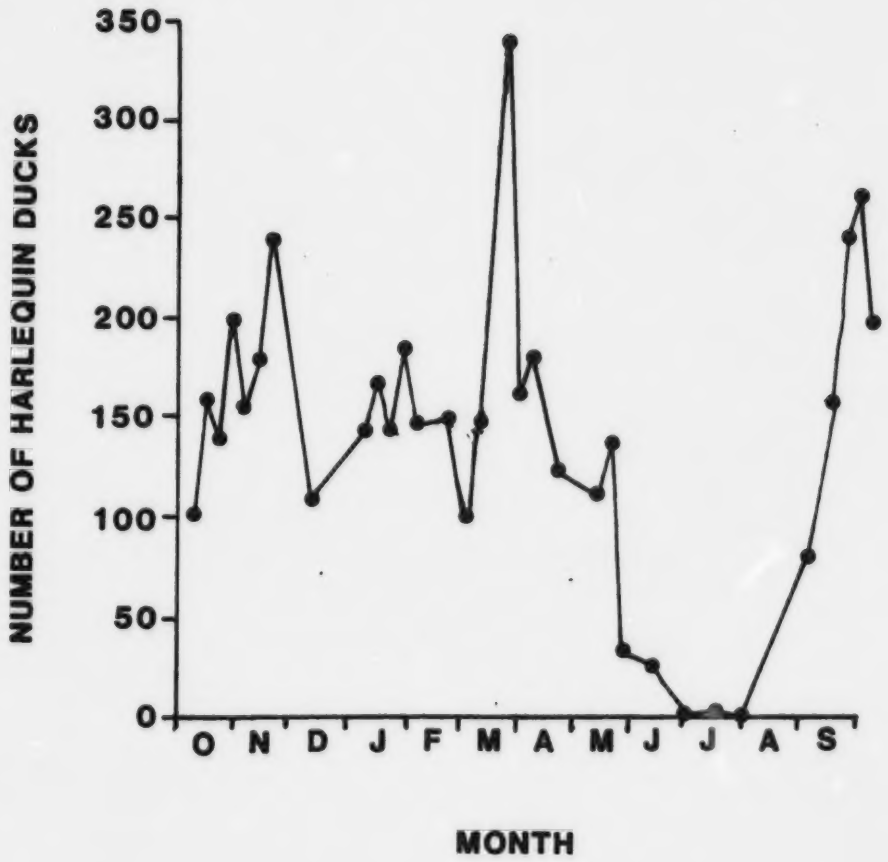

Figure 2.7. Seasonal abundance of Harlequin Ducks in the Comox area.

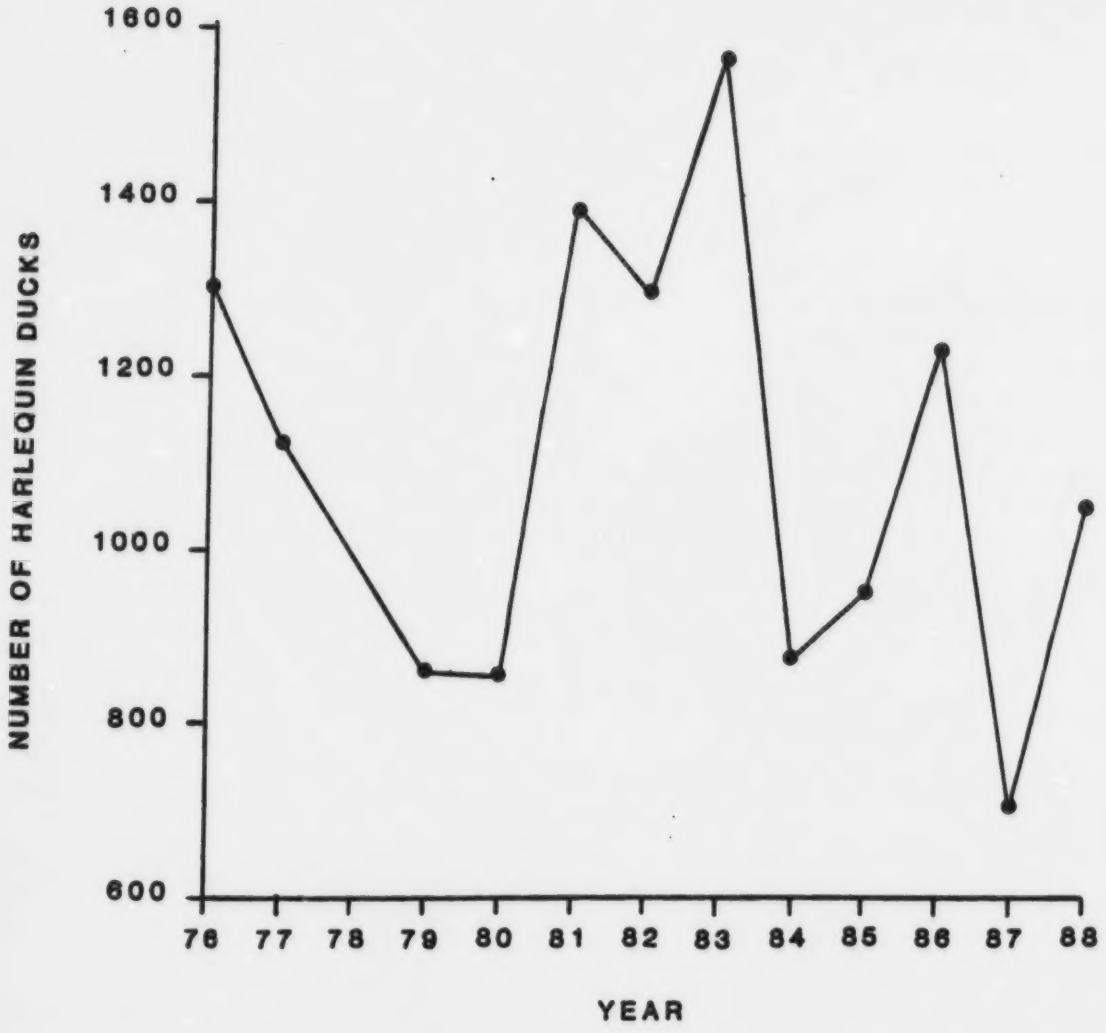

Figure 2.8. Abundance of Harlequin Ducks in Christmas Bird Counts from 1978 to 1988.

There are multiple records of broods using lakes in British Columbia, but whether this indicates breeding attempts or movements through lakes is unknown. There are 2 records of broods using glacial lakes or streams. This is unusual, as glacial waters are thought to be insufficiently productive to allow the presence of broods (Cramp and Simmons 1977). More information would be needed to determine the extent to which glacier-fed waters are used.

More information is available on molting/wintering Harlequin Ducks. Available data showed a minimum overall wintering population of 6186 individuals. True population size is undoubtedly much higher, because 1) little data is available for remote coastal areas; 2) most coastal surveys in remote areas were conducted from airplanes and Harlequin Ducks are difficult to locate and count from airplanes and 3) ground surveys covered only a portion of the coastline in each zone.

Limited data is available to compare molting and wintering distribution of Harlequin Ducks. Key molting sites and molting abundance have been described in Savard (1988b). A study on marked Harlequin Ducks in White Rock indicated that 1) Harlequins show site-specific attachment to wintering sites, 2) molting sites are also used as wintering sites and 3) molting sites comprise only a fraction of the wintering habitat (Savard and Breault, in prep.).

Prior to our review, major known wintering areas included the Victoria area, the southeastern coast of Vancouver Island and the northern Queen Charlotte Islands (Savard 1988b; Campbell *et al.* 1990), which, other than the Queen Charlotte Islands, correspond to some of the most accessible areas along the British Columbia coast. Our review identified concentrations of at least 200 individuals on the southeast coast of Vancouver Island (Comox and Baynes Sound area, Nanaimo area, Saanich Peninsula, Victoria); along the mainland at the north tip of Vancouver Island (Seymour, Belize and Smith Inlets); on the North Coast (Prince Rupert area) and in the Queen Charlotte Islands (Cumshewa Head and Burnaby Strait area). The presence of large concentrations of Harlequin Ducks in remote coastal areas (e.g. Seymour, Belize and Smith Inlets and the Queen Charlotte Islands) suggest that current understanding of wintering distribution and abundance is biased by surveying effort and technique, and that sites with large numbers of wintering birds may have been overlooked.

Maximum counts in the Baynes Sound/Comox area were obtained in late March, corresponding to Pacific herring (*Clupea herengus pallassi*) spawning time (see Hay *et al.* in Vermeer and Butler 1989). For all other areas surveyed, maximum counts occured much later than herring spawning time. There is no evidence that Harlequin Ducks aggregate during herring spawning time at locations other than the Baynes Sound area.

As determined from counts conducted in the Comox-Deep Bay area, Harlequin Ducks departed for the breeding grounds in two waves: in the last week of March-early April and in the third week of May. Few individuals were observed on the coast from early June to late July. Arrival to wintering grounds occurred throughout September, and wintering numbers remained more or less constant over the winter months. The absence of Harlequin Ducks in the summer months indicates that the Comox-Deep Bay area is not used by non-breeders during summer. Late arrival to wintering grounds (in September) indicates that the Comox-Deep Bay area is not used by molting individuals, as breeding males molt in June and breeding females start molting in July (see chapter 1).

We detected extensive variations in the total number of Harlequin Ducks surveyed during Christmas Bird Counts conducted in 8 areas from 1976 to 1988, with maximum abundance observed in 1983. We could not find any differences in the pattern of yearly fluctuations across zones, suggesting that fluctuations in populations occurred simultaneously through all zones. No data is available as to the causes of those fluctuations.

CHAPTER 3: CONSERVATION AND MANAGEMENT

1) Status in eastern North America:

The former population of Harlequin Ducks in eastern North America was estimated at 5000-10,000 individuals by Goudie (1989b), but the population is now at less than 1000 individuals (Vickery 1988). Harlequin Ducks in Newfoundland and Nova Scotia are still declining, and the remaining population may be near or below a viable population size of 500 breeding individuals (Goudie 1989a).

Observed declines on the east coast of North America are thought to result from a combination of factors (Goudie 1989a): 1) hunting pressure; 2) relative tameness compared to other waterfowl; 3) small number of "significant" wintering sites accounting for the majority of the regional population; 4) small initial population size; 5) decreases in habitat quality; 6) contamination from toxic pollutants such as oil; and 7) acidification of breeding habitat, affecting fish and invertebrate abundance.

Prososed solutions to insure the protection of the species, which has been designated "endangered" in eastern North America (COSEWIC 1990) include 1) protect sites of significant importance, and 2) obtain a better understanding of reproductive and wintering ecology (Goudie 1989a).

2) Status in British Columbia:

The situation of Harlequin Ducks in British Columbia is undoubtedly less precarious than in eastern North America. An estimated 4000 to 8000 pairs breed in British Columbia (Bellrose 1976) and wintering populations may range into the high 10,000's (Campbell *et al.* 1990). These estimates are however based on very sparse data and could be wrong. No information is available on past distribution and abundance in British Columbia.

Philips (1925) and Palmer (1949) linked hunting, more than any other factor, to the decline of Harlequin Ducks on the East Coast of North America, because they are relatively tame compared to other seaducks species (Palmer 1976) and they forage in shallow waters close to shore (Goudie 1989a). Harlequin Ducks are not subject to high hunting pressure in British Columbia (Metras 1985; Dickson 1989), but their gregariousness and pattern of habitat use raises conservation concerns.

Harlequin Ducks breed and raise young on fast-flowing streams (see Chapter 1). With logging, mining and grazing having detrimental effects on stream ecology, productivity of Harlequin Ducks may decrease, along with the number of streams used by breeding individuals. The lack of information on breeding distribution and habitat requirements in British Columbia (only 53

nesting records for the province) (see Chapter 2) might make it impossible to assess future changes in habitat or distribution.

In British Columbia, wintering Harlequin Ducks are concentrated in small areas on the east coast of Vancouver Island and in the Queen Charlotte Islands. The largest concentrations have so far been observed in Georgia Strait, where toxic pollutants are abundant (Waldichuk 1983) and where commercial, industrial and recreational development of coastal areas might affect abundance and quality of key wintering habitat.

3) Suggestions for management

Although Harlequin Ducks are abundant in the province (see above), their protection and management are severely impaired by our lack of understanding of their biology and distribution. This section identifies the information needed to design a comprehensive management plan for Harlequin Ducks.

Efforts should be invested into 1) locating breeding, molting and wintering populations; 2) protecting and monitoring key molting and wintering areas; and 3) understanding Harlequin Duck reproductive ecology with respect to habitat selection, factors affecting reproductive success, molting and wintering distribution, effects of contaminants and human disturbance.

Establishing breeding and wintering distribution and abundance should be the number one priority. No information is available on breeding habitat, and Harlequin Ducks are gregarious and philopatric to a limited number of sites outside the breeding season (Savard and Breault, in prep.). Outstanding nesting areas could be lost before being identified, while threats to their wintering habitat would affect significant portions of the local population. The second priority should be to protect and closely monitor areas supporting more than 100 individuals, because of their importance to the overall population. Finally, information should be gathered on the breeding distribution and reproductive ecology of Harlequin Ducks in British Columbia, on which almost no information is currently available.

Specifically, we recommend that:

1- Surveys be conducted to identify rivers and streams used by Harlequin Ducks during the breeding season in British Columbia. Once identified, major breeding areas should be regularly monitored and whenever possible protected.

Breeding densities could be established in different parts of British Columbia by displaying posters in all provincial and federal parks in the province (parks already account for the majority of pair and brood sightings currently available).

Posters were effectively used in Idaho to raise public awareness of the species and to gather information on breeding distribution (Cassirer 1989). Field surveys of breeding pairs should be conducted in mid or late May, preferably by helicopter. Most birds are on their breeding sites at that time, and females have not yet started to incubate (Bengston 1972).

2- Surveys be conducted to determine molting distribution and wintering population size and location of Harlequin Ducks in British Columbia.

Those surveys would be used to identify key molting and wintering areas and to refine available population estimates. Surveying should solely focus on Harlequin Ducks, because conventional seaduck surveys do not adequately cover the species. Aerial surveys should be avoided unless they both 1) aim exclusively at Harlequin Ducks and 2) are calibrated from ground counts.

3- Molting and wintering areas (known and to be identified from future studies) used by at least 100 individuals should be protected and monitored every 3 years. Because overall distribution is extremely localized (Fleishner 1983), development proposals for key sites should be on hold until further information is available on overall wintering population size and distribution.

4- Extensive research on breeding Harlequin Ducks covering: 1) reproductive success and habitat selection; 2) effects of disturbance of reproductive success and 3) effects of industrial development on stream quality and breeding distribution.

Information is needed on habitat use by breeding Harlequin Ducks in British Columbia. Studies should cover food availability and diet, stream type, vegetation and loafing site use and water regime, which have all been related to reproductive performance (see Chapter 1). Development within prime breeding habitats should take into account Harlequin Duck breeding requirements.

Because breeding adults require undisturbed habitat and breeding seems to take place in areas with little or no human use (see chapter 2), a study should compare reproductive behavior between areas free from and subject to human disturbance. Multiple-use areas might be possible depending on how Harlequin Ducks are affected by human activity. Management of human disturbance [e.g. angling (Wallen 1987)] should be a priority in the management of Harlequin Ducks.

No explanations are currently available as to the causes of high frequency of non-breeders, apparent low reproductive success, causes of mortality and biased sex-ratios. High ratio of non-breeders could be related to human disturbance, to presence of yearlings on nesting areas, to disappearance or alteration of breeding habitat and/or to food limitation.

Marking techniques and telemetry should be used to determine the percentage of individuals seen in breeding areas that are actual breeders and to relate breeding distribution to molting and wintering distribution. Specific sub-populations found along the coast should be identified and related to specific breeding areas.

Wintering distribution of Harlequin Ducks in southern coastal British Columbia overlaps areas of heavy dioxin contamination and commercial fisheries closures have occurred in areas used by significant numbers of wintering birds. Heavy boat and oil traffic along the coast also raises the possibility of localized incidents affecting large local populations. No information on the health status of Harlequin Ducks wintering in those areas are available.

5- Any studies considering molting, wintering ecology or reproductive ecology of Harlequin Ducks in British Columbia be encouraged and financially supported.

CHAPTER 4: OVERALL DISCUSSION

1) General Biology

Harlequin Ducks breed on streams where water quality is sufficiently good to support healthy insect populations and where human activities are limited. Preferred streams are 10m wide or more, with a gradient of less than 3-5% and presence of high quality riparian shrubs (Bengston 1966; Kuchel 1977; Dzinbal 1982; Wallen 1987; Wallen and Groves 1989).

Breeding biology studies have concluded that food availability (as opposed to nest site availability) determines choice of breeding habitat and reproductive success (Bengston 1966; 1972; Bengston and Ulfstrand 1971; Kuchel 1977). In Iceland, about 80% of females seen on breeding areas did not lay eggs in a year with sparse food supply (Bengston and Ulfstrand 1971), suggesting females do not breed when food is scarce at the time of egg-laying (Bengston 1972). Logging, mining and grazing can have drastic impacts on stream ecology. Decreases in stream quality resulting from those practices might affect both productivity and overall distribution in the province. No study has yet documented current distribution and stream ecology in nesting areas.

In Iceland, choice of wintering habitat is thought to be determined by substrate type, and hence availability of food (Bengston 1966). Preference for rocky shorelines as wintering habitat (Palmer 1976) might explain why studies conducted in the Puget Sound (e.g. Hirsch 1980; Fleischner 1983) had much smaller wintering populations than recorded in British Columbia. Gregariousness on the wintering grounds, full wing molt and high densities in Georgia Strait raises the possibility that localized incidents (e.g. oil spills during molt period) might affect significant numbers of birds.

Precise estimates of the number of breeders in the province cannot be estimated from available data, although Bellrose (1976) estimated 4000-8000 breeding pairs in the province and Campbell *et al.* (1990) estimated up to high 10,000 wintering individuals. Breeding records have been found for coastal and interior areas, at altitudes ranging from sea level to alpine areas. A significant portion of available breeding records originate from protected areas such as parks, probably because of increased accessibility and use by naturalists.

Surveys of wintering birds accounted for a minimum of 6186 individuals, with large wintering concentrations observed in Georgia Strait, the Queen Charlotte Islands and on the mainland at the north end of Vancouver Island. Most known key wintering areas in the province coincide with areas for which multiple surveys are available, suggesting that current understanding of wintering distribution is biased by the number of surveys available. Because 1) few surveys have been conducted on the northern coast and 2)

available surveys covered only a portion of each coastal zone, the real wintering population is undoubtedly much higher than 6200 individuals.

2) Studying distribution and abundance

Studies of distribution and abundance of breeding and wintering Harlequin Ducks are severely limited by the accuracy of surveying techniques and by the cryptic eclipse plumage of the species. It has been shown that multiple species counts are less accurate than single species counts (Watson et al. 1969; Savard 1982; Savard and Kaiser 1982), but extensive surveys focussing primarily on Harlequin Ducks have rarely been conducted (but see Savard and Breault, in prep.). Their habit of staying close to shore also decreases their detectability, and most aerial surveys are conducted at some distance from the shoreline. Different options are available to gather much needed information on breeding and wintering abundance of Harlequin Ducks. Programs conducted in Wyoming and Idaho used posters located along trails and in National Parks to gather information on distribution and productivity of breeding pairs. Ground surveys along coastline routes would provide useful information on molting and wintering ecology, but the nature of the British Columbia coastline makes this impossible at most locations. Aerial surveys could be used along stretches of the coastline, but the surveys would have to concentrate on Harlequin Ducks only.

3) Conservation and management priorities

Harlequin Ducks have been designated "endangered" in eastern North America (COSEWIC 1990) and both a "sensitive species" and a "species of special concern" by the U.S. Forest Service in Idaho, because of low population densities and apparent need for undisturbed habitat for breeding (Cassirer 1989). Wallen (1987) suggested that Harlequin Ducks be used as indicators of wilderness and pristine ecosystems, and many items in the Harlequin's diet are considered biological indicators of healthy streams (Pennak 1978).

The protection of local Harlequin Duck populations will only become possible when extensive information becomes available on regional distribution, abundance and on general reproductive and wintering ecology. Harlequin Ducks appear abundant in the province, but available information is insufficient to determine past or future fluctuations in distribution and abundance, and provides little information on habitat use and reproductive ecology. We recommend 1) surveys of breeding and wintering populations; 2) protection and monitoring of key sites; and 3) studies of habitat use and reproductive behavior.

The most serious threats to an effective management of the species reside in our poor understanding of their distribution, habitat requirements and reproductive biology in British Columbia.

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Appendix 1. Summary of mid-winter flight inventories of Harlequin Ducks in coastal British Columbia

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 1 - PORT HARDY TO CAPE SCOTT:					
Jepther Pt - Cape Scott Park	76	Oct	20	1	Air
AREA 2 - N COAST OF QUEEN CHARLOTTE STRAIT:					
Outer Coast	79	Nov	05	11	Air
AREA 3 - BEAVER COVE TO PORT HARDY:					
Beaver Cove - E of Willow Cr	77	Jan	06	1	Air
Ledge Pt to Thomas Pt	77	Jan	06	6	Air
Ledge Pt to Thomas Pt	79	Oct	30	4	Air
Port McNeill Bay	77	Jan	06	11	Air
AREA 4 - DISCOVERY PASSAGE AND JOHNSTON STRAIT:					
Brown Bay to E of Salmon Bay	75	Feb	14	6	Air
Duncan Bay to Seymour Narrows	77	Jan	07	4	Air
Duncan Bay to Seymour Narrows	79	Oct	31	4	Air
Kelsey and Brasseau Bay	77	Jan	07	2	Air
N Shore Johnston Strait	79	Nov	01	2	Air
N Shore Johnston Strait	80	Apr	01	1	Air
Brasseau Bay to Bauza Cove	76	Jan	21	1	Air
Brasseau Bay to Bauza Cove	79	Oct	31	5	Air
AREA 5 - CAPE LAZO TO CAMPBELL RIVER:					
Black Creek	76	Spring		17	Unkn
Campbell River ferry ship	76	Jan	21	29	Air
Cape Lazo to Black Creek	76	Jan	21	70	Air
Cape Lazo TO Black Creek	77	Jan	07	9	Air
Cape Lazo to Black Creek	77	Mar	17	10	Air
Cape Lazo to Black Creek	77	Nov	21	51	Air
Cape Lazo to Black Creek	79	Oct	31	58	Air
Cape Lazo to Black Creek	80	Jan	29	165	Air
Cape Lazo to Black Creek	80	Mar	11	119	Air
Cape Lazo to Black Creek	80	Mar	25	117	Air
Kubushan Pt - Discovery Pass	75	Feb	14	11	Air
Kubushan Pt - Discovery Pass	76	Apr	21	4	Air
Kubushan Pt - Discovery Pass	76	Mar	03	2	Air
Kubushan Pt - Discovery Pass	76	Spring		4	Unkn
Kubushan Pt - Discovery Pass	77	Jan	07	3	Air
Kubushan Pt - Discovery Pass	77	Mar	17	10	Air
Kubushan Pt - Discovery Pass	77	Nov	21	12	Air

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 5 - CAPE LAZO TO CAMPBELL RIVER:					
Kubushan Pt - Discovery Pass	80	Jan	29	19	Air
Kubushan Pt - Discovery Pass	80	Mar	11	29	Air
Miracle Beach	76	Mar	14	3	Air
Oyster River Estuary	74	Apr	10	4	Grnd
Oyster River Estuary	74	Mar	29	4	Grnd
Oyster River Estuary	74	MAY	03	34	Grnd
Oyster River Estuary	76	Apr	20	12	Air
Oyster River Estuary	76	Jan	21	2	Air
Oyster River Estuary	76	Mar	03	1	Grnd
Oyster River Estuary	77	Mar	17	2	Air
Oyster River Estuary	79	Oct	31	6	Air
Oyster River Estuary	80	Jan	29	6	Air
Oyster River Estuary	80	Mar	25	2	Air
AREA 6 - COMOX TO NANAIMO:					
Ballenas Channel	80	Jan	29	1	Air
Ballenas Channel	80	Mar	11	2	Air
Base Flat to Gartley Pt	80	Mar	25	5	Air
Base Flat to Gartley Pt	75	Feb	14	10	Air
Base Flat to Gartley Pt	76	Apr	21	2	Air
Base Flat to Gartley Pt	76	Jan	21	1	Air
Base Flat to Gartley Pt	76	Mar	03	2	Air
Base Flat to Gartley Pt	77	Jan	07	4	Air
Base Flat to Gartley Pt	77	Mar	17	12	Air
Base Flat to Gartley Pt	77	Nov	21	3	Air
Base Flat to Gartley Pt	80	Jan	29	11	Air
Base Flat to Gartley Pt	80	Mar	11	5	Air
Comox Harbor and Estuary	76	Jan	21	3	Air
Comox Harbor and Estuary	76	Mar	03	1	Air
Comox Harbor and Estuary	77	Jan	07	33	Air
Comox Harbor and Estuary	77	Oct	31	2	Air
Englshmn Estry-Northwest Bay	75	Feb	14	4	Air
Englshmn Estry-Northwest Bay	76	Jan	21	2	Air
Englshmn Estry-Northwest Bay	76	Mar	03	1	Air
Englshmn Estry-Northwest Bay	79	Oct	31	11	Air
Englshmn Estry-Northwest Bay	80	Mar	25	10	Air
Goose Spit to Cape Lazo	76	Mar	03	1	Air
Goose Spit to Cape Lazo	77	Mar	17	2	Air
Goose Spit to Cape Lazo	79	Oct	31	15	Air
Goose Spit to Cape Lazo	80	Jan	29	13	Air
Goose Spit to Cape Lazo	80	Mar	25	1	Air
Goose Spit to Cape Lazo	80	Mar	11	7	Air
Horswell Bluff to Blunden Pt	72	Feb	01	5	Boat

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 6 - COMOX TO NANAIMO:					
Horswell Bluff to Blunden Pt	72	Oct	28	4	Boat
Horswell Bluff to Blunden Pt	77	Nov	21	3	Air
Little Qualicum Riv Estuary	77	Jan	07	3	Air
Little Qualicum Riv Estuary	80	Feb	21	2	Grnd
Little Qualicum Riv Estuary	80	Mar	11	20	Air
Nanoose Harbor and Estuary	76	Jan	21	1	Air
Nanoose Harbor and Estuary	77	Mar	15	100	Air
Nanoose Harbor and Estuary	80	Feb	21	2	Grnd
Nanoose Harbor and Estuary	80	Mar	11	6	Air
Parksvlle Bay-S Mapleguard Pt	63	Jan	08	2	Air
Parksvlle Bay-S Mapleguard Pt	75	Feb	14	17	Air
Parksvlle Bay-S Mapleguard Pt	76	Apr	21	3	Air
Parksvlle Bay-S Mapleguard Pt	76	Jan	21	34	Air
Parksvlle Bay-S Mapleguard Pt	76	Mar	03	3	Air
Parksvlle Bay-S Mapleguard Pt	76	Nov	21	11	Air
Parksvlle Bay-S Mapleguard Pt	77	Jan	07	3	Air
Parksvlle Bay-S Mapleguard Pt	77	Mar	17	57	Air
Parksvlle Bay-S Mapleguard Pt	77	Nov	21	6	Air
Parksvlle Bay-S Mapleguard Pt	79	Oct	31	90	Air
Parksvlle Bay-S Mapleguard Pt	80	Jan	29	64	Air
Parksvlle Bay-S Mapleguard Pt	80	Mar	11	157	Air
Ship Pt to Mapleguard Pt	76	Jan	21	3	Air
Ship Pt to Mapleguard Pt	76	Mar	14	2	Air
Ship Pt to Mapleguard Pt	77	Jan	07	2	Air
Ship Pt to Mapleguard Pt	80	Mar	11	5	Air
AREA 7 - MILL BAY TO NANAIMO:					
Chemainus to Coffin Pt	62	Oct	14	15	Air
Chemainus to Coffin Pt	71	Dec	06	2	Boat
Chemainus to Coffin Pt	72	Mar	07	10	Boat
Chemainus to Coffin Pt	74	Dec	31	18	Grnd
Chemainus to Coffin Pt	74	Dec	26	4	Grnd
Chemainus to Coffin Pt	74	Dec	20	8	Grnd
Chemainus to Coffin Pt	74	Dec	15	2	Grnd
Chemainus to Coffin Pt	75	Feb	20	11	Grnd
Chemainus to Coffin Pt	75	Feb	12	11	Grnd
Chemainus to Coffin Pt	75	Feb	06	2	Grnd
Chemainus to Coffin Pt	75	Feb	01	8	Grnd
Chemainus to Coffin Pt	75	Jan	05	2	Grnd
Chemainus to Coffin Pt	75	Jan	15	12	Grnd
Chemainus to Coffin Pt	75	Jan	25	8	Grnd
Chemainus to Coffin Pt	75	Jan	20	10	Grnd
Chemainus to Coffin Pt	75	Jan	10	12	Grnd

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 7 - MILL BAY TO NANAIMO:					
Chemainus to Coffin Pt	75	Mar	15	2	Grnd
Coffin Pt to Yellow Pt	71	Dec	06	31	Boat
Coffin Pt to Yellow Pt	71	Nov	01	34	Boat
Coffin Pt to Yellow Pt	72	Mar	07	17	Boat
Coffin Pt to Yellow Pt	76	Jan	21	10	Air
Coffin Pt to Yellow Pt	77	Jan	03	10	Air
Coffin Pt to Yellow Pt	79	Nov	01	23	Air
Coffin Pt to Yellow Pt	80	Mar	29	7	Air
Cowichan Bay Area	71	Nov	02	2	Boat
Cowichan Bay Area	72	Jan	18	1	Boat
Crofton-Chemainus	63	Jan	08	5	Air
Crofton-Chemainus	74	Dec	15	2	Grnd
Crofton-Chemainus	75	Feb	18	1	Grnd
Crofton-Chemainus	75	Feb	03	5	Grnd
Crofton-Chemainus	75	Jan	18	1	Grnd
Crofton-Chemainus	79	Nov	01	1	Air
Departure Bay	62	Oct	14	15	Air
Jack Pt to Yellow Pt	71	Dec	06	12	Boat
Jack Pt to Yellow Pt	71	Nov	01	23	Boat
Jack Pt to Yellow Pt	71	Oct	29	2	Boat
Jack Pt to Yellow Pt	72	Mar	07	37	Boat
Jack Pt to Yellow Pt	72	Mar	06	1	Boat
Jack Pt to Yellow Pt	77	Jan	03	4	Air
Jack Pt to Yellow Pt	79	Nov	01	15	Boat
Maple Bay and Sansum Narrows	72	Mar	08	2	Boat
Newcastle and Protection Is	71	Nov	19	5	Boat
Newcastle and Protection Is	72	Mar	07	5	Boat
AREA 8 - GULF ISLANDS:					
Active Pass	77	Mar	26	6	Air
De Courcy Group	71	Nov	19	20	Boat
De Courcy Group	71	Oct	29	19	Boat
De Courcy Group	72	Jan	14	50	Boat
De Courcy Group	72	Jan	11	2	Boat
De Courcy Group	72	Mar	17	31	Boat
E coast of Galiano	71	Nov	15	12	Boat
E coast of Galiano	72	Jan	21	6	Boat
E coast of Galiano	72	Jan	19	5	Boat
E coast of Galiano	72	Mar	14	8	Boat
E coast of Galiano	76	Feb	06	1	Air
E coast Saltspring Island	71	Dec	07	6	Boat
E coast Saltspring Island	71	Dec	08	56	Boat
E coast Saltspring Island	71	Nov	03	62	Boat

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 8 - GULF ISLANDS:					
E coast Saltspring Island	71	Nov	02	2	Boat
E coast Saltspring Island	72	Feb	08	20	Boat
E coast Saltspring Island	72	Feb	09	54	Boat
E coast Saltspring Island	72	Jan	13	5	Boat
E coast Saltspring Island	72	Jan	07	19	Boat
E coast Saltspring Island	72	Jan	12	10	Boat
E coast Saltspring Island	72	Mar	07	60	Boat
E coast Saltspring Island	72	Mar	23	21	Boat
E coast Saltspring Island	72	Mar	08	11	Boat
E coast Saltspring Island	72	Mar	09	21	Boat
E coast Saltspring Island	77	Jan	03	1	Air
E coast Saltspring Island	77	Mar	26	37	Air
E coast Saltspring Island	79	Oct	25	9	Air
E coast Saltspring Island	80	Apr	16	13	Air
E coast Saltspring Island	80	Feb	04	2	Air
Gabriola Island Northeast	62	Oct	14	25	Air
Gabriola Island Northeast	71	Oct	28	38	Boat
Gabriola Island Northeast	72	Jan	13	12	Boat
Gabriola Island Northeast	72	Jan	21	53	Boat
Gabriola Island Northeast	72	Jan	13	2	Boat
Gabriola Island Northeast	72	Mar	13	82	Boat
Gabriola Island Northeast	76	Jan	21	5	Air
Gabriola Island Northeast	76	Mar	14	6	Air
Gabriola Island Southwest	71	Oct	27	42	Boat
Gabriola Island Southwest	72	Feb	02	6	Boat
Gabriola Island Southwest	72	Jan	13	8	Boat
Gabriola Island Southwest	72	Jan	14	14	Boat
Gabriola Island Southwest	72	Mar	17	5	Boat
Gabriola Island Southwest	72	Mar	13	20	Boat
Gabriola Island Southwest	76	Jan	21	2	Air
Gabriola Island Southwest	76	Mar	14	2	Air
Gabriola Island Southwest	80	Apr	16	21	Air
Galiano Island Northeast	80	Apr	16	18	Air
Georgia Strait	72	Jan	13	8	Boat
Georgia Strait	72	Mar	09	7	Boat
Georgia Strait	72	Mar	04	7	Boat
Mayne Island	71	Nov	16	2	Boat
Mayne Island	71	Nov	17	17	Boat
Mayne Island	72	Jan	20	2	Boat
Mayne Island	72	Jan	19	7	Boat
Mayne Island	72	Mar	14	6	Boat
Mayne Island	77	Mar	26	10	Air
Mayne Island	80	Feb	04	12	Air
N Pender Island	71	Nov	17	5	Boat

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 8 - GULF ISLANDS:					
N Pender Island	72	Dec	10	3	Boat
N Pender Island	72	Jan	18	3	Boat
N Pender Island	72	Jan	20	2	Boat
N Pender Island	72	Jan	19	2	Boat
N Pender Island	72	Mar	16	5	Boat
N Pender Island	72	Mar	15	2	Boat
N Pender Island	72	Mar		1	Boat
N Pender Island	77	Mar	26	20	Air
N Pender Island	80	Apr	16	4	Air
Navey Channel	71	Nov	17	2	Boat
Porlier Pass	76	Feb	06	2	Unkn
Porlier Pass	76	Mar		6	Unkn
Prevost Island	71	Dec	10	18	Boat
Prevost Island	71	Dec	09	11	Boat
Prevost Island	71	Nov	18	11	Boat
Prevost Island	72	Jan	12	7	Boat
Prevost Island	72	Jan	13	22	Boat
Prevost Island	72	Mar	09	72	Boat
Prevost Island	72	Mar	16	6	Boat
Prevost Island	72	Nov	02	14	Boat
Prevost Island	79	Oct	25	7	Air
Prevost Island	80	Apr	16	2	Air
S coast Saltspring Island	71	Nov	02	8	Boat
S coast Saltspring Island	71	Nov	02	7	Boat
S coast Saltspring Island	72	Jan	11	7	Boat
S coast Saltspring Island	72	Jan	18	39	Boat
S coast Saltspring Island	72	Mar	08	20	Boat
S coast Saltspring Island	77	Mar	26	2	Air
S coast Saltspring Island	79	Oct	26	2	Air
S coast Saltspring Island	80	Apr	16	3	Air
S coast Saltspring Island	80	Apr	16	4	Air
S coast Saltspring Island	80	Feb	04	8	Air
S Pender Island	71	Nov	17	9	Boat
S Pender Island	72	Jan	19	5	Boat
S Pender Island	72	Mar	15	11	Boat
S Pender Island	72	Mar	16	2	Boat
S Pender Island	76	Mar	14	3	Air
S Pender Island	77	Mar	26	12	Air
S Pender Island	80	Apr	16	4	Air
Samuel Island	71	Dec	09	39	Boat
Samuel Island	71	Nov	16	10	Boat
Samuel Island	71	Nov	17	18	Boat
Samuel Island	72	Jan	19	43	Boat
Samuel Island	72	Mar	14	30	Boat

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 8 - GULF ISLANDS:					
Saturna Island North	71	Nov	16	75	Boat
Saturna Island North	72	Jan	19	85	Boat
Saturna Island North	72	Mar	15	86	Boat
Saturna Island North	77	Mar	26	57	Air
Saturna Island North	80	Apr	16	12	Air
Saturna Island North	80	Feb	04	8	Air
Saturna Island South	71	Dec	09	4	Boat
Saturna Island South	71	Nov	16	5	Boat
Saturna Island South	72	Jan	20	4	Boat
Saturna Island South	72	Mar	15	44	Boat
Saturna Island South	76	Mar	14	1	Air
Saturna Island South	80	Feb	04	2	Air
Sidney Island	70	Dec	18	6	Air
Stuart Channel	71	Nov	03	20	Boat
Stuart Channel	72	Jan	12	12	Boat
Stuart Channel	72	Mar	10	2	Boat
Stuart Channel	72	Mar	22	4	Boat
Stuart Channel	72	Mar	7,23	16	Boat
Stuart Channel	77	Jan	03	10	Air
Thetis and Kuper Is	71	Dec	07	1	Boat
Thetis and Kuper Is	71	Nov	03	14	Boat
Thetis and Kuper Is	72	Mar	22	10	Boat
Thetis and Kuper Is	80	Apr	16	35	Air
Trincomali Channel	71	Dec	10	10	Boat
Trincomali Channel	71	Dec	07	10	Boat
Trincomali Channel	71	Nov	18	10	Boat
Trincomali Channel	71	Nov	3.18	6	Boat
Trincomali Channel	71	Nov	18	18	Boat
Trincomali Channel	72	Jan	12	9	Boat
Trincomali Channel	72	Mar	10.23	8	Boat
Trincomali Channel	72	Mar	17	3	Boat
Trincomali Channel	72	Mar	16	16	Boat
Trincomali Channel	72	Mar	23	3	Boat
Trincomali Channel	76	Feb	06	2	Air
Valdez Island N and E coasts	71	Nov	15	14	Boat
Valdez Island N and E coasts	71	OctNov	28/15	5	Boat
Valdez Island N and E coasts	72	Jan	13	24	Boat
Valdez Island N and E coasts	72	Mar	13	12	Boat
Valdez Island N and E coasts	72	Mar	14	9	Boat
Valdez Island N and E coasts	76	Feb	06	6	Air
Valdez Island N and E coasts	76	Jan	21	6	Air
Valdez Island S and W coasts	71	Dec	10	10	Boat
Valdez Island S and W coasts	72	Jan	18	7	Boat
Valdez Island S and W coasts	72	Mar	17	8	Boat

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 8 - GULF ISLANDS:					
Valdez Island S and W coasts	72	Mar	13	2	Boat
Valdez Island S and W coasts	72	Mar	14	2	Boat
Valdez Island S and W coasts	72	Oct	29	15	Boat
Valdez Island S and W coasts	76	Jan	21	6	Air
Valdez Island S and W coasts	77	Jan	03	4	Air
W coast of Galiano	71	Dec	09	2	Boat
W coast of Galiano	71	Dec	10	2	Boat
W coast of Galiano	71	Nov	04	5	Boat
W coast of Galiano	72	Mar	17	4	Boat
W coast of Galiano	77	Jan	03	1	Air
W coast Saltspring Island	76	Feb	03	3	Air
W coast Saltspring Island	77	Mar	26	4	Air
W coast Saltspring Island	79	Oct	25	25	Air
W coast Saltspring Island	80	Apr	16	4	Air
AREA 9 - SAANICH PENINSULA:					
Cadboro Pt to Gordon Head	62	Dec	26	10	Air
Cadboro Pt to Gordon Head	62	Nov	28	15	Air
Cadboro Pt to Gordon Head	62	Nov	14	10	Air
Cadboro Pt to Gordon Head	62	Oct	30	5	Air
Cadboro Pt to Gordon Head	62	Oct	16	5	Air
Cadboro Pt to Gordon Head	63	Jan	22	5	Air
Cadboro Pt to Gordon Head	77	Mar	18	4	Air
Cadboro Pt to Gordon Head	79	Oct	15	2	Air
Cadboro Pt to Gordon Head	80	Apr	16	3	Air
Chatham and Discovery Is	62	Dec	14	50	Air
Chatham and Discovery Is	62	Dec	26	90	Air
Chatham and Discovery Is	62	Nov	28	40	Air
Chatham and Discovery Is	62	Nov	14	65	Air
Chatham and Discovery Is	62	Oct	2,4	140	Air
Chatham and Discovery Is	62	Oct	16	140	Air
Chatham and Discovery Is	63	Jan	22	35	Air
Chatham and Discovery Is	70	Dec	18	11	Air
Chatham and Discovery Is	62	Oct	30	95	Air
Cordova Bay	62	Oct	16	20	Air
Cordova Bay	62	Oct	30	5	Air
Cordova Bay	70	Dec	18	4	Air
Cordova Spit to Swartz Head	77	Feb	08	25	Air
Cordova Spit to Swartz Head	80	Apr	16	17	Air
D'Arcy Island	62	Dec	14	5	Air
D'Arcy Island	62	Dec	26	10	Air
D'Arcy Island	62	Nov	14	10	Air
D'Arcy Island	62	Oct	30	5	Air

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 9 - SAANICH PENINSULA:					
D'Arcy Island	62	Oct	16	5	Air
James Island	62	Dec	26	5	Air
James Island	70	Dec	18	10	Air
James Island	79	Oct	29	15	Air
James Island	80	Apr	16	10	Air
Little Group	62	Dec	26	5	Air
Little Group	62	Nov	28	5	Air
Little Group	62	Oct	16	10	Air
Little Group	63	Feb	12	5	Air
Little Group	63	Jan	22	5	Air
Moresby Island	76	Mar	14	2	Air
Moresby Island	76	Mar	26	3	Air
Oak Bay and Cadboro Bay	77	Mar	18	5	Air
Oak Bay and Cadboro Bay	51	NovMar		50	Boat
Oak Bay and Cadboro Bay	62	Nov	16	10	Air
Oak Bay and Cadboro Bay	62	Nov	28	5	Air
Oak Bay and Cadboro Bay	62	Oct	30	30	Air
Oak Bay and Cadboro Bay	62	Oct	2,4	45	Air
Oak Bay and Cadboro Bay	63	Jan	22	12	Air
Oak Bay and Cadboro Bay	76	Jan	12	113	Boat
Oak Bay and Cadboro Bay	77	Feb	08	3	Air
Patricia Bay	80	Apr	16	2	Air
Portland Island	77	Mar	26	3	Air
Prevost Channel	77	Mar	26	12	Air
Sidney Island	62	Dec	26	5	Air
Sidney Island	62	Nov	14	15	Air
Sidney Island	62	Oct	16	5	Air
Sidney Island	77	Mar	26	2	Air
Sidney Island	79	Oct	25	29	Air
Sidney Island	80	Apr	14	2	Air
Sidney Island	80	Feb	04	20	Air
Swartz Head to Moses Pt	79	Oct	15	6	Air
Swartz Head to Moses Pt	80	Apr	16	2	Air
Victoria Hbr to Gonzales Pt	62	Dec	14	10	Air
Victoria Hbr to Gonzales Pt	62	Dec	26	25	Air
Victoria Hbr to Gonzales Pt	62	Nov	14	20	Air
Victoria Hbr to Gonzales Pt	62	Nov	28	10	Air
Victoria Hbr to Gonzales Pt	62	Oct	16	60	Air
Victoria Hbr to Gonzales Pt	62	Oct	2,4	25	Air
Victoria Hbr to Gonzales Pt	62	Oct	30	20	Air
Victoria Hbr to Gonzales Pt	63	Jan	22	25	Air
Victoria Hbr to Gonzales Pt	70	Dec	18	2	Air

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REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 10 - VICTORIA HARBOR TO CAPE CALVER:					
Esquimalt Hbr	77	Mar	18	12	Air
AREA 11 - SW COAST OF VANCOUVER ISLAND:					
Bentick I to Possession Pt	70	Dec	18	4	Air
Bentick I to Possession Pt	77	Feb	08	20	Air
Cape Beale to San Juan Pt	77	Mar	18	3	Air
Cape Beale to San Juan Pt	79	Jul	13	31	Air
Cape Beale to San Juan Pt	79	Oct	15	10	Air
Cape Beale to San Juan Pt	80	Jan	23	150	Air
AREA 12 - BARKLEY SOUND:					
Alma Russel I to Chup Pt	79	Oct	15	1	Air
Loudoun Channel	80	Mar	24	2	Air
AREA 14 - CLAYOQUOT SOUND:					
Cypress Bay	72	Dec	12	2	Boat
Fortune Channel	72	Dec	11	1	Boat
AREA 15 - DAGGER PT TO ESTEVAN PT:					
Hesquiat Hbr - Hotspring Cove	76	Jan	19	27	Air
Hesquiat Hbr - Hotspring Cove	79	Oct	29	10	Air
Hesquiat Hbr - Hotspring Cove	80	Mar	25	2	Air
AREA 16 - NOOTKA SOUND:					
Cook Chnl and Bligh Island SW	76	Jan	19	3	Air
Cook Chnl and Bligh Island SW	79	Oct	30	5	Air
Estevan Pt to Concepcion Pt	76	Jan	19	2	Air
AREA 17 - NOOTKA ISLAND W AND ESPERANZA ISLAND:					
Maquinna Pt to Ferrer Pt	76	SPRING		3	Air
Zeballos Inlet	77	Jan	05	34	Air
AREA 20 - BROOKS BAY:					
Klaskino Inlet	79	Oct	30	2	Air

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 22 - CAPE SCOTT TO CAPE PARKINS:					
Hansens's Lagoon and Bay	73	Oct	25,28	4	Air
AREA 26 - HOWE SOUND:					
Caufield to Porteau	79	Oct	04	10	Air
Thornbrough and Shoal Chans	76	Feb	06	4	Air
AREA 27 - SECHELT PENINSULA:					
Gower Pt to Sargeant Bay	79	Oct	04	37	Air
Gower Pt to Sargeant Bay	80	Jan	30	6	Air
Gower Pt to Sargeant Bay	80	Mar	31	1	Air
Reception Pt to Pender Hbr	77	Nov	21	2	Air
Reception Pt to Pender Hbr	79	Oct	04	1	Air
Reception Pt to Pender Hbr	80	Jan	30	5	Air
AREA 29 - JERVIS INLET, SW NELSON ISLAND AND AGAMEMNON CHANNEL:					
Evenden Pt to Culloden Pt	77	Mar	16	15	Air
Jervis Inlet-Desolation Sound	77	Mar	16	10	Air
Scotch Fir Pt to Sarah Pt	79	Oct	05	18	Air
Scotch Fir Pt to Sarah Pt	80	Jan	30	16	Air
Scotch Fir Pt to Sarah Pt	80	Mar	31	60	Air
AREA 30 - TEXADA AND LASQUETI ISLANDS:					
Lasqueti Island	80	Jan	30	2	Air
Texada Island N and E coasts	80	Jan	30	2	Air
Texada Island S	80	Jan	30	5	Air
AREA 32 - DESOLATION SOUND AND SUTIL CHANNEL:					
Okeover Int-SE Desolation Snd	80	Jan	30	8	Air
AREA 33 - TOBA INLET:					
Toba Inlet	77	Mar	16	1	Air
Toba Inlet	80	Apr	01	1	Air
AREA 34 - SE QUADRA ISLAND AND CORTEZ ISLAND:					
Cape Mudge to Viner Pt	77	Nov	21	5	Air

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 35 - BUTE INLET:					
West coast	79	Oct	31	4	Air
AREA 36 - LOUGHBOROUGH INLET:					
Sunderland + Chancellor chans	79	Nov	01	6	Air
Sunderland + Chancellor chans	80	Apr	01	3	Air
AREA 39 - TRIBUNE CHANNEL AND FIFE SOUND:					
E of Deepsea Bluff/Powell Pt	80	Apr	01	3	Air
AREA 41 - SUTLEY CHANNEL TO DRURY INLET:					
Outer coast	80	Apr	08	5	Air
AREA 44 - SMITH SOUND TO CAPE MARK:					
Goose Island Group	53	May		10	Boat
AREA 45 - FITZ HUGH SOUND, DEAN AND BURKE CHANNELS:					
Burke Channel	79	Nov	06	5	Air
Fitz Hugh Sound E coast	79	Nov	06	24	Air
Fitz Hugh Sound E coast	80	Apr	08	2	Air
AREA 46 - SEAFORTH AND FINLAYSON CHANNELS:					
Finlayson Channel	80	Apr	08	12	Air
Seaforth/Spiller+nearby chans	75	Jan	30	12	Air
AREA 47 - LAREDO AND ESTEVAN SOUND, PRINCESS ROYAL ISLAND:					
Estevan Group	77	Jan	18	31	Air
Estevan Group	79	Sep	13	9	Air
Laredo Sound Channel	79	Nov	08	17	Air
Outer coast Aristazabal I	77	Mar	23	2	Air
Princess Royal Channel	79	Nov	07	3	Air
AREA 48 - GARDNER AND DOUGLAS CHANNELS:					
Devastation and Gardner chans	76	Feb	19	1	Air

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 49 - BANKS ISLAND TO GRENVILLE CHANNEL:					
Grenville Chnl, Union Pass	77	Jan	21	1	Air
Grenville Chnl, Union Pass	79	Sep	13	10	Air
Outer coast of Banks I	77	Jun	17	15	Air
Outer coast of Banks I	77	Jan	18	23	Air
Outer coast of Banks I	77	Mar	23	6	Air
Outer coast of Banks I	77	Nov	15	46	Air
Outer coast of Banks I	77	Oct	18	109	Air
Outer coast of Banks I	78	Feb	15	93	Air
Outer coast of Banks I	78	Jan	11	47	Air
Principe+Petrel chans,McCauley	77	Jan	21	10	Air
Principe+Petrel chans,McCauley	78	Jan	10	3	Air
Principe+Petrel chans,McCauley	79	Sep	14	1	Air
Principe+Petrel chans,McCauley	79	Sep	13	11	Air
AREA 50 - PORCHER ISLAND AND TELEGRAPH PASSAGE:					
Kinkatla Inlet Area	77	Jan	18	2	Air
Kinkatla Inlet Area	77	Jan	21	7	Air
Kinkatla Inlet Area	77	May	11	8	Boat
Kinkatla Inlet Area	77	Nov	15	6	Air
Kinkatla Inlet Area	77	Oct	18	23	Air
Kinkatla Inlet Area	78	Feb	16	6	Air
Kinkatla Inlet Area	78	Feb	15	41	Air
Kinkatla Inlet Area	78	Jan	10	22	Air
N and W coasts of Porcher I	77	Feb	27	83	Boat
N and W coasts of Porcher I	77	Jan	18	6	Air
N and W coasts of Porcher I	77	Mar	24	1	Air
N and W coasts of Porcher I	77	Mar	22	11	Boat
N and W coasts of Porcher I	77	Nov	04	81	Boat
N and W coasts of Porcher I	77	Nov	15	36	Air
N and W coasts of Porcher I	77	Oct	18	104	Air
N and W coasts of Porcher I	77	Sep	08	7	Boat
N and W coasts of Porcher I	78	Feb	16	7	Air
N and W coasts of Porcher I	78	Feb	15	78	Air
N and W coasts of Porcher I	78	Jan	10	112	Air
Telegraph Pass + E Porcher I	77	Oct	17/18	2	Air
Telegraph Pass + E Porcher I	78	Jan	10	3	Air
AREA 51 - CHATHAM SOUND:					
Chatham Sound	77	Nov	16	12	Air
Chatham Sound	77	Nov	15	4	Air
Chatham Sound	77	Oct	17/18	25	Air
Chatham Sound	78	Feb	16	4	Air

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 51 - CHATHAM SOUND:					
Chatham Sound	78	Feb	15	18	Air
Chatham Sound	78	Jan	12	9	Air
Chatham Sound	78	Jan	11	10	Air
Chatham Sound	78	Jan	10	13	Air
Chatham Sound	78	Jan	09	5	Air
Dundas I	77	Nov	16	49	Air
Dundas I	77	Oct	17/18	5	Air
Dundas I	78	Feb	16	29	Air
Dundas I	78	Jan	11	68	Air
Dundas I	78	Mar	22	2	Air
Dundas I	79	Sep	13	119	Air
Mainland coast	77	Jan	20	2	Air
Mainland coast	77	Mar	23	4	Air
Mainland coast	77	Nov	16	1	Air
Mainland coast	77	Nov	05	5	Boat
Mainland coast	77	Oct	17/18	17	Air
Mainland coast	77	Sep	23	98	Boat
Mainland coast	77	Sep	14	16	Boat
Mainland coast	78	Feb	13	7	Air
Mainland coast	78	Feb	16	14	Air
Mainland coast	78	Feb	15	2	Air
Mainland coast	78	Jan	12	5	Air
Mainland coast	78	Jan	11	11	Air
Mainland coast	78	Jan	10	2	Air
Mainland coast	78	Jan	19	103	Boat
Mainland coast	78	Mar	14	2	Boat
Mainland coast	79	Sep	11	8	Air
Mainland coast	80	Apr	10	50	Air
Mainland coast	80	Feb	05	12	Boat
Stephens I	77	Nov	16	4	Air
Stephens I	77	Oct	17	43	Air
Stephens I	78	Feb	16	39	Air
Stephens I	79	Sep	14	19	Air
AREA 52 - PORTLAND INLET:					
Nass Bay and River	80	Apr	10	10	Air
Nass River Area	77	Oct	17	92	Air
Portland Inlet	78	Feb	16	4	Air
Portland Inlet	78	Jan	11	1	Air
Portland Inlet	79	Sep	11	6	Air
Portland Inlet	80	Apr	10	2	Air

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REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 54 - ENTRY POINT TO ROSE SPIT:					
Entry Point to Rose Spit	77	Nov	14	3	Air
Entry Point to Rose Spit	77	Oct	17	45	Air
Entry Point to Rose Spit	78	Feb	13	8	Air
Entry Point to Rose Spit	78	Jan	09	5	Air
Entry Point to Rose Spit	78	Jan	06	3	Air
Entry Point to Rose Spit	79	Aug	19	4	Grnd
Entry Point to Rose Spit	80	Apr	12	10	Air
Entry Point to Rose Spit	80	Feb	28	21	Air
AREA 55 - MASSET SOUND:					
Masset Sound	79	Sep	20	23	Grnd
AREA 56 - MASSET INLET:					
Dinan Bay to Makai Point	79	Sep	19	25	Air
Kumdis I to Matus I	80	Apr	13	2	Air
Kumdis I to Matus I	80	Feb	28	4	Air
AREA 57 - PARRY PASSAGE TO MASSET HARBOUR:					
Outer coast	74	Feb	19	Abundant	Boat
Naden Hbr	80	Apr	12	4	Air
Naden Hbr	80	Feb	28	7	Air
Naden Hbr	76	Mar		Abundant	Unkn
Outer coast	80	Apr	13	3	Air
Outer coast	77	Jan	17	13	Air
Outer coast	77	Mar	22	19	Air
Outer coast	77	Nov	14	3	Air
Outer coast	77	Oct	17	94	Air
Outer coast	78	Feb	13	167	Air
Outer coast	78	Jan	09	167	Air
Outer coast	79	Sep	18	5	Air
Outer coast	79	Sep	20	145	Air
Outer coast	80	Apr	12	127	Air
Outer coast	80	Feb	28	88	Air
AREA 58 - LANGARA ISLAND:					
Langara Island	77	Nov	14	2	Air
Langara Island	77	Oct	17	25	Air
Langara Island	79	Sep	20	8	Unkn

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REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 59 - TIAN HEAD TO CAPE KNOX:					
Morgan Point to Cape Knox	79	Sep	20	10	Air
Tian Head to Kennecott Bay	79	Sep	20	81	Air
AREA 60 - KUNAKUN PT TO TIAN HEAD:					
Kindakun Pt to Selvensen Pt	80	Apr	12	3	Air
Louis Pt to Tian Head	80	Apr	12	2	Air
AREA 61 - RENNELL SOUND:					
Rennell Sound	76	Oct	20	23	Air
Rennell Sound	80	Apr	12	8	Air
Shields Bay	80	Apr	12	50	Air
AREA 62 - TANA BAY TO CONE HEAD:					
Humer Pt to Cone Head	80	Apr	12	27	Air
Humer Pt to Cone Head	80	Feb	29	7	Air
AREA 63 - SKIDEGATE AND BUCK CHANNELS:					
Skidegate Channel	72	Jan		35	Boat
Skidegate Channel	75	Jan	29	5	Air
Skidegate Channel	77	Jan	15	2	Air
Skidegate Channel	80	Apr	12	20	Air
Skidegate Channel	80	Feb	28	3	Air
AREA 64 - ENGLEFIELD BAY TO DAVIDSON POINT:					
Englefield Bay	72	Jan		21	Boat
AREA 65 - TASU SOUND:					
Botany Inlet	73	Jan	30/31	2	Boat
AREA 66 - TASU HEAD TO NAGAS POINT:					
Gowgoia Bay	80	Apr	14	10	Air
AREA 68 - KUNGHIT ISLANDS:					
E Kunghit I	80	Apr	14	5	Air
Rose Int+Houston Stewart chan	79	Sep	19	2	Air
Rose Int+Houston Stewart chan	80	Apr	14	3	Air

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REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 69 - CARPENTER BAY:					
Carpenter Bay	75	MayJun		3	Air
Carpenter Bay	79	Sep	19	2	Air
Carpenter Bay	80	Apr	14	35	Air
Deluge Pt to Iron Pt	80	Apr	14	1	Air
Deluge Pt to Iron Pt	80	Feb	28	3	Air
AREA 70 - SKINCUTTLE INLET:					
N Shore of Skincuttle Inlet	80	Feb	28	1	Air
S Shore of Skincuttle Inlet	79	Sep	19	8	Air
S Shore of Skincuttle Inlet	80	Feb	28	13	Air
AREA 71 - BURNABY STRAIT AND BURNABY ISLAND:					
North Portion	79	Sep	19	5	Air
South Portion	80	Feb	28	6	Air
AREA 72 - JUAN PEREZ SOUND:					
Hoskins Pt to Werner Pt	80	Feb	28	2	Air
AREA 73 - DODGE POINT TO RAMSAY ISLAND:					
E coast of Lyell I	75	MayJun		1	Air
E coast of Lyell I	80	Apr	13	26	Air
Faraday Pass to Murchison I.	80	Apr	13	6	Air
AREA 74 - LOGAN INLET, DARWIN SOUND AND SEDGWICK BAY:					
Darwin Sound	80	Apr	14	5	Air
Darwin Sound	80	Apr	13	4	Air
Darwin Sound	80	Feb	28	6	Air
Logan Inlet	77	Jan	17	15	Air
Logan Inlet	80	Apr	13	35	Air
Logan Inlet	80	Feb	27	6	Air
Atli Inlet	75	MayJun		7	Air
AREA 75 - LOUISE ISLAND AND LASKEEK BAY:					
Dana Inlet	80	Apr	13	5	Air
Dana Inlet	80	Feb	27	4	Air
Outer coast Louise I	80	Apr	13	15	Air

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 76 - CUMSHEWA INLET:					
Cumshewa Inlet	77	Jan	17	2	Air
Cumshewa Inlet	79	Sep	16	5	Boat
Cumshewa Inlet	79	Sep	21	5	Air
Cumshewa Inlet	80	Apr	13	22	Air
Cumshewa Inlet	80	Feb	27	40	Air
AREA 77 - CUMSHEWA HD TO SANDSPIT:					
Copper Bay	79	Sep	21	15	Air
Copper Bay	80	Apr	14	2	Air
Cumshewa Hd to Gray Pt	77	Jan	17	2	Air
Cumshewa Hd to Gray Pt	78	Feb	15	26	Air
Cumshewa Hd to Gray Pt	80	Apr	13	4	Air
Cumshewa Hd to Gray Pt	80	Feb	27	32	Air
Gray Bay	78	Feb	15	37	Air
Gray Bay	80	Apr	14	8	Air
Gray Bay	80	Apr	13	200	Air
Gray Bay to Copper Bay	80	Apr	14	9	Air
Sandspit to Copper Bay	77	Jan	18	30	Air
Sandspit to Copper Bay	77	Oct	18	74	Air
Sandspit to Copper Bay	78	Feb	15	29	Air
Sandspit to Copper Bay	78	Jan	11	14	Air
Sandspit to Copper Bay	79	Sep	18	25	Air
Sandspit to Copper Bay	80	Apr	14	2	Air
Sandspit to Copper Bay	80	Apr	13	8	Air
Sandspit to Copper Bay	80	Feb	27	8	Air
AREA 78 - SKIDEGATE INLET:					
Bearskin Bay	78	Feb	15	13	Air
Bearskin Bay	78	Jan	05	4	Grnd
Bearskin Bay	78	Jan	08	2	Grnd
Bearskin Bay	79	Sep	13	2	Air
Shingle Bay Area	78	Feb	15	2	Air
Shingle Bay Area	80	Apr	12	77	Air
Skidegate Inlet	76	Oct	21	10	Air
Skidegate Inlet	77	Feb	13	6	Grnd
Skidegate Inlet	77	Jan	15	37	Air
Skidegate Inlet	77	Sep	18	9	Air
Skidegate Inlet	78	Feb	15	45	Air
Skidegate Inlet	78	Jan	11	2	Air
Skidegate Inlet	79	Sep	18	10	Air
Skidegate Inlet	80	Apr	12	68	Air
Skidegate Inlet	80	Feb	29	35	Air

App. 1. (cont'd).

REGION	YEAR	MONTH	DATE	NUMBER SEEN	SURVEY TYPE
AREA 78 - SKIDEGATE INLET:					
Skidegate Inlet	80	Feb	28	12	Air
AREA 79 - EAST COAST OF GRAHAM ISLAND:					
Rose Spit to Tlell	78	Feb	13	1	Air
Rose Spit to Tlell	80	Apr	12	59	Air
Skidegate to Tlell	77	Jan	15	9	Air
Skidegate to Tlell	77	Mar	23	3	Air
Skidegate to Tlell	77	Oct	18	1	Air
Skidegate to Tlell	78	Feb	15	20	Air
Skidegate to Tlell	78	Jan	11	23	Air
Skidegate to Tlell	78	Jan	05	84	Grnd
Skidegate to Tlell	79	Sep	18	10	Air
Skidegate to Tlell	80	Apr	12	59	Air
Skidegate to Tlell	80	Feb	28	4	Air
Skidegate to Tlell	80	Feb	29	5	Air
Tlell	55	Winter		4	Unkn

Appendix 2. Summary of recent published and unpublished surveys of Harlequin Ducks in coastal British Columbia

AREA	YEAR	MONTH	DAY	NUMBER OBSERVED	SURVEY TYPE	SOURCE
Ladysmith	1974	Dec	15	2	Gnd	Trethewey unpubl.
Ladysmith	1974	Dec	20	8	Gnd	Trethewey unpubl.
Ladysmith	1974	Dec	25	4	Gnd	Trethewey unpubl.
Ladysmith	1974	Dec	30	18	Gnd	Trethewey unpubl.
Ladysmith	1975	Jan	01	2	Gnd	Trethewey unpubl.
Ladysmith	1975	Jan	08	12	Gnd	Trethewey unpubl.
Ladysmith	1975	Jan	15	12	Gnd	Trethewey unpubl.
Ladysmith	1975	Jan	22	10	Gnd	Trethewey unpubl.
Ladysmith	1975	Jan	29	8	Gnd	Trethewey unpubl.
Ladysmith	1975	Feb	06	8	Gnd	Trethewey unpubl.
Ladysmith	1975	Feb	13	2	Gnd	Trethewey unpubl.
Ladysmith	1975	Feb	20	11	Gnd	Trethewey unpubl.
Ladysmith	1975	Feb	27	11	Gnd	Trethewey unpubl.
Ladysmith	1975	Mar	06	0	Gnd	Trethewey unpubl.
Ladysmith	1975	Mar	15	2	Gnd	Trethewey unpubl.
Chemainus	1974	Dec	16	2	Gnd	Trethewey unpubl.
Chemainus	1974	Dec	22	0	Gnd	Trethewey unpubl.
Chemainus	1975	Jan	02	0	Gnd	Trethewey unpubl.
Chemainus	1975	Jan	09	0	Gnd	Trethewey unpubl.
Chemainus	1975	Jan	16	0	Gnd	Trethewey unpubl.
Chemainus	1975	Jan	23	1	Gnd	Trethewey unpubl.
Chemainus	1975	Jan	30	0	Gnd	Trethewey unpubl.
Chemainus	1975	Feb	07	5	Gnd	Trethewey unpubl.
Chemainus	1975	Feb	14	0	Gnd	Trethewey unpubl.
Chemainus	1975	Feb	21	1	Gnd	Trethewey unpubl.
Chemainus	1975	Feb	28	0	Gnd	Trethewey unpubl.
Chemainus	1975	Mar	07	0	Gnd	Trethewey unpubl.
Chemainus	1975	Mar	16	0	Gnd	Trethewey unpubl.
Dixon Entrance						
Section 4-5	1977	Oct	17	18	Air	Savard 1978a
Section 8-9	1977	Oct	17	1	Air	Savard 1978a
Section 11-12	1977	Oct	17	25	Air	Savard 1978a
Section 12-13	1977	Oct	17	18	Air	Savard 1978a
Section 13-14	1977	Oct	17	50	Air	Savard 1978a
Section 14-15	1977	Oct	17	24	Air	Savard 1978a
Section 15-16	1977	Oct	17	45	Air	Savard 1978a
Hecate Strait:						
Section 26-27	1977	Oct	18	1	Air	Savard 1978a
Section 29-30	1977	Oct	18	6	Air	Savard 1978a
Section 30-31	1977	Oct	18	68	Air	Savard 1978a
Section 34-35	1977	Oct	18	13	Air	Savard 1978a
Section 38-39	1977	Oct	18	14	Air	Savard 1978a
Section 40-41	1977	Oct	18	35	Air	Savard 1978a

App. 2. ctd'd.

AREA	YEAR	MONTH	DAY	NUMBER OBSERVED	SURVEY TYPE	SOURCE
Hecate Strait:						
Section 42-43	1977	Oct	18	47	Air	Savard 1978a
Section 43-44	1977	Oct	18	23	Air	Savard 1978a
Section 44-45	1977	Oct	18	104	Air	Savard 1978a
Hecate Strait:						
Section 45-46	1977	Oct	18	8	Air	Savard 1978a
Section 21-47	1977	Oct	18	2	Air	Savard 1978a
Chatham Sound:						
Section 3-4	1977	Oct	17	3	Air	Savard 1978a
Section 24-25	1977	Oct	17	2	Air	Savard 1978a
Section 26-27	1977	Oct	17	3	Air	Savard 1978a
Section 27-28	1977	Oct	17	12	Air	Savard 1978a
Section 38-39	1977	Oct	17	2	Air	Savard 1978a
Section 39-40	1977	Oct	17	7	Air	Savard 1978a
Section 41-42	1977	Oct	17	7	Air	Savard 1978a
Section 42-43	1977	Oct	17	35	Air	Savard 1978a
Dixon Entrance:						
Section 11-12	1977	Nov	14	2	Air	Savard 1978c
Section 14-15	1977	Nov	14	3	Air	Savard 1978c
Section 15-16	1977	Nov	14	3	Air	Savard 1978c
Hecate Strait:						
Section 30-31	1977	Nov	15	29	Air	Savard 1978c
Section 38-39	1977	Nov	15	5	Air	Savard 1978c
Section 40-41	1977	Nov	15	17	Air	Savard 1978c
Section 42-43	1977	Nov	15	24	Air	Savard 1978c
Section 43-44	1977	Nov	15	3	Air	Savard 1978c
Section 44-45	1977	Nov	15	36	Air	Savard 1978c
Section 45-46	1977	Nov	15	4	Air	Savard 1978c
Chatham Sound:						
Section 3-4	1977	Nov	16	8	Air	Savard 1978c
Section 4-5	1977	Nov	16	28	Air	Savard 1978c
Section 7-8	1977	Nov	16	1	Air	Savard 1978c
Section 18-19	1977	Nov	16	2	Air	Savard 1978c
Section 19-20	1977	Nov	16	10	Air	Savard 1978c
Section 20-21	1977	Nov	16	4	Air	Savard 1978c
Section 21-22	1977	Nov	16	15	Air	Savard 1978c
Section 24-25	1977	Nov	16	2	Air	Savard 1978c
Section 25-26	1977	Nov	16	4	Air	Savard 1978c
Section 43-44	1977	Nov	15	3	Air	Savard 1978c

App. 2. ctd'd.

AREA	YEAR	MONTH	DAY	NUMBER OBSERVED	SURVEY TYPE	SOURCE
Dixon Entrance:						
Section 13-14	1978	Feb	13	1	Air	Savard 1978e
Section 16-17	1978	Feb	13	21	Air	Savard 1978e
Section 17-19	1978	Feb	13	76	Air	Savard 1978e
Section 19-20	1978	Feb	13	17	Air	Savard 1978e
Section 22-23	1978	Feb	13	33	Air	Savard 1978e
Section 23-24	1978	Feb	13	19	Air	Savard 1978e
Section 24-25	1978	Feb	13	4	Air	Savard 1978e
Section 25-26	1978	Feb	13	4	Air	Savard 1978e
Section 28-29	1978	Feb	13	1	Air	Savard 1978e
Section 31-1	1978	Feb	13	7	Air	Savard 1978e
Hecate Strait:						
Section 30-32	1978	Feb	15	12	Air	Savard 1978e
Section 34-35	1978	Feb	15	20	Air	Savard 1978e
Section 35-36	1978	Feb	15	12	Air	Savard 1978e
Section 36-37	1978	Feb	15	1	Air	Savard 1978e
Section 37-38	1978	Feb	15	30	Air	Savard 1978e
Section 38-39	1978	Feb	15	8	Air	Savard 1978e
Section 39-40	1978	Feb	15	7	Air	Savard 1978e
Section 40	1978	Feb	15	2	Air	Savard 1978e
Section 41-42	1978	Feb	15	24	Air	Savard 1978e
Section 42-42A	1978	Feb	15	5	Air	Savard 1978e
Section 43-44	1978	Feb	15	37	Air	Savard 1978e
Section 44-45	1978	Feb	15	26	Air	Savard 1978e
Section 49-50	1978	Feb	15	5	Air	Savard 1978e
Section 53-54	1978	Feb	15	13	Air	Savard 1978e
Section 55-56	1978	Feb	15	44	Air	Savard 1978e
Section 57-59	1978	Feb	15	31	Air	Savard 1978e
Section 60-61	1978	Feb	15	41	Air	Savard 1978e
Section 61-62	1978	Feb	15	66	Air	Savard 1978e
Section 62-63	1978	Feb	15	18	Air	Savard 1978e
Section 31-1	1978	Feb	15	2	Air	Savard 1978e
Chatham Sound:						
Section 5-6	1978	Feb	16	4	Air	Savard 1978e
Section 6-7	1978	Feb	16	23	Air	Savard 1978e
Section 7-8	1978	Feb	16	2	Air	Savard 1978e
Section 9-10	1978	Feb	16	5	Air	Savard 1978e
Section 11-12	1978	Feb	16	1	Air	Savard 1978e
Section 22-23	1978	Feb	16	2	Air	Savard 1978e
Section 23-24	1978	Feb	16	5	Air	Savard 1978e
Section 25-26	1978	Feb	16	19	Air	Savard 1978e
Section 26-27	1978	Feb	16	15	Air	Savard 1978e
Section 28-28A	1978	Feb	16	4	Air	Savard 1978e
Section 3-2	1978	Feb	16	4	Air	Savard 1978e

App. 2. ctd'd.

AREA	YEAR	MONTH	DAY	NUMBER OBSERVED	SURVEY TYPE[1]	SOURCE
Chatham Sound:						
Section 43-44	1978	Feb	16	3	Air	Savard 1978e
Section 51-52	1978	Feb	16	3	Air	Savard 1978e
Section 59-60	1978	Feb	16	7	Air	Savard 1978e
Section 61-62	1978	Feb	16	8	Air	Savard 1978e
Section 62-63	1978	Feb	16	4	Air	Savard 1978e
Section 63-64	1978	Feb	16	39	Air	Savard 1978e
Section 65-66	1978	Feb	16	8	Air	Savard 1978e
Dixon Entrance:						
Section 8-9	1978	Jan	12	9	Air	Savard 1978d
Section 10-1	1978	Jan	12	5	Air	Savard 1978d
Section 12-13	1978	Jan	09	5	Air	Savard 1978d
Section 15-16	1978	Jan	09	5	Air	Savard 1978d
Section 17-18	1978	Jan	09	13	Air	Savard 1978d
Section 19-20	1978	Jan	09	1	Air	Savard 1978d
Section 21-22	1978	Jan	09	11	Air	Savard 1978d
Section 22-23	1978	Jan	09	43	Air	Savard 1978d
Section 23-24	1978	Jan	09	8	Air	Savard 1978d
Section 24-25	1978	Jan	09	2	Air	Savard 1978d
Section 25-26	1978	Jan	09	19	Air	Savard 1978d
Section 26-27	1978	Jan	09	70	Air	Savard 1978d
Hecate Strait:						
Section 39-40	1978	Jan	11	23	Air	Savard 1978d
Section 42-43	1978	Jan	11	2	Air	Savard 1978d
Section 44-45	1978	Jan	11	14	Air	Savard 1978d
Section 58-59	1978	Jan	11	4	Air	Savard 1978d
Section 59-60	1978	Jan	11	12	Air	Savard 1978d
Section 63-64	1978	Jan	11	31	Air	Savard 1978d
Chatham Sound:						
Section 61-62	1978	Jan	10	3	Air	Savard 1978d
Section 63-64	1978	Jan	10	3	Air	Savard 1978d
Section 64-65	1978	Jan	10	16	Air	Savard 1978d
Section 66-67	1978	Jan	10	102	Air	Savard 1978d
Section 67-68	1978	Jan	10	5	Air	Savard 1978d
Section 69-70	1978	Jan	10	13	Air	Savard 1978d
Section 71-72	1978	Jan	10	2	Air	Savard 1978d
Section 72-73	1978	Jan	10	8	Air	Savard 1978d
Section 75-76	1978	Jan	10	1	Air	Savard 1978d
Section 77-78	1978	Jan	10	2	Air	Savard 1978d
Section 79-80	1978	Jan	10	2	Air	Savard 1978d

App. 2. ctd'd.

AREA	YEAR	MONTH	DAY	NUMBER OBSERVED	SURVEY TYPE[1]	SOURCE
Chatham Sound North:						
Section 5-6	1978	Jan	11	9	Air	Savard 1978d
Section 6-7	1978	Jan	11	16	Air	Savard 1978d
Section 7-8	1978	Jan	11	4	Air	Savard 1978d
Section 10-11	1978	Jan	11	2	Air	Savard 1978d
Section 20-21	1978	Jan	11	1	Air	Savard 1978d
Section 22-23	1978	Jan	11	1	Air	Savard 1978d
Section 23-24	1978	Jan	11	6	Air	Savard 1978d
Section 24-25	1978	Jan	11	11	Air	Savard 1978d
Section 26-27	1978	Jan	11	30	Air	Savard 1978d
Section 28-29	1978	Jan	11	10	Air	Savard 1978d
Chatham Sound North:						
Shoal Harbour	1977	Oct		9	Gnd	Dawe 1982
Shoal Harbour	1977	Nov		8	Gnd	Dawe 1982
Shoal Harbour	1977	Dec		6	Gnd	Dawe 1982
Shoal Harbour	1978	Jan		6	Gnd	Dawe 1982
Shoal Harbour	1978	Feb		5	Gnd	Dawe 1982
Shoal Harbour	1978	Mar		0	Gnd	Dawe 1982
Shoal Harbour	1978	Apr		1	Gnd	Dawe 1982
Tofino:						
Park beaches	1989	Jan - Feb		2	Dead	Rodway *et al.* 1989
Park beaches	1989	Jan	12	1	Dead	Rodway *et al.* 1989
Park beaches	1989	Jan	15	1	Dead	Rodway *et al.* 1989
Unidentified	1989	Jan - Feb		1	Dead	Rodway *et al.* 1989
Barkley Sound:						
Pachena Bay	1989	Jan - Feb		2	Heli	Rodway *et al.* 1989
Keeha Bay	1989	Jan - Feb		3	Heli	Rodway *et al.* 1989
N Effingham I.	1989	Jan	19	18	Heli	Rodway *et al.* 1989
NW Prideaux I.	1989	Jan	21	21	Heli	Rodway *et al.* 1989
Tofino:						
Estevan to Burwood Pts	1989	Jan	14	3	Heli	Rodway *et al.* 1989
Nuchalitz Its (W Lord I.)	1989	Feb	02	10	Heli	Rodway *et al.* 1989
Cape Sutil to Cape Scott	1989	Jan	15	4	Heli	Rodway *et al.* 1989
Moore I	1989	Jan	27	2	Heli	Rodway *et al.* 1989
EM-040	1986	Jun	06	1	Gnd	Rodway *et al.* 1988
EM-140	1986	Jun	19	1	Gnd	Rodway *et al.* 1988
EM-160	1986	Jun	19	3	Gnd	Rodway *et al.* 1988
EM-220	1985	May	3-15	13	Gnd	Rodway *et al.* 1988

App. 2. ctd'd.

AREA	YEAR	MONTH	DAY	NUMBER OBSERVED	SURVEY TYPE[1]	SOURCE
EM-230	1986	Jun	19	4	Gnd	Rodway *et al.* 1988
EM-250	1986	Jun	19	16	Gnd	Rodway *et al.* 1988
EM-260	1986	Jun	16-19	30	Gnd	Rodway *et al.* 1988
EM-270	1985	Apr - Jun		6	Gnd	Rodway *et al.* 1988
EM-280	1985	Apr	27-30	2	Gnd	Rodway *et al.* 1988
EM-300	1985	Apr - Jun		2	Gnd	Rodway *et al.* 1988
EM-300	1985	Apr - Jun		8	Gnd	Rodway *et al.* 1988
EM-400	1985	Apr	16-23	255	Gnd	Rodway *et al.* 1988
EM-430	1986	Jun	19	57	Gnd	Rodway *et al.* 1988
EM-470	1984	Apr - May		3	Gnd	Rodway *et al.* 1988
EM-480	1986	Jun	19	26	Gnd	Rodway *et al.* 1988
EM-490	1985	Jun	16	48	Gnd	Rodway *et al.* 1988
EM-500	1984	Apr - Jun		15	Gnd	Rodway *et al.* 1988
EM-510	1984	Apr - May		18	Gnd	Rodway *et al.* 1988
EM-550	1984, 1985 and 1986			9	Gnd	Rodway *et al.* 1988
EM-580	1982	Apr - Jun		31	Gnd	Rodway *et al.* 1988
EM-580	1982	Apr - Jun		32	Gnd	Rodway *et al.* 1988
EM-640	1983	May	12	2	Gnd	Rodway *et al.* 1988
EM-640	1983	May	12	4	Gnd	Rodway *et al.* 1988
EM-700	1983, 1986			2	Gnd	Rodway *et al.* 1988
EM-710	1983	Apr - May		18	Gnd	Rodway *et al.* 1988
EM-740	1983	May	8-10	4	Gnd	Rodway *et al.* 1988
W Moresby:						
Adam Rocks	1985	May	29	1	Boat	Rodway unpubl.
Campbell River:						
Estuary	1973	Jan	19	3	Gnd	Trethewey unpubl.
Estuary	1973	Jan	31	0	Gnd	Trethewey unpubl.
Estuary	1973	Feb	15	6	Gnd	Trethewey unpubl.
Estuary	1973	Feb	28	4	Gnd	Trethewey unpubl.
Estuary	1973	Mar	15	12	Gnd	Trethewey unpubl.
Estuary	1973	Mar	21	0	Gnd	Trethewey unpubl.
Estuary	1973	Mar	28	3	Gnd	Trethewey unpubl.
Estuary	1974	Jan	10	0	Gnd	Trethewey unpubl.
Estuary	1974	Jan	16	0	Gnd	Trethewey unpubl.
Estuary	1974	Jan	23	0	Gnd	Trethewey unpubl.
Estuary	1974	Jan	29	1	Gnd	Trethewey unpubl.
Estuary	1974	Feb	5	0	Gnd	Trethewey unpubl.
Estuary	1974	Feb	13	0	Gnd	Trethewey unpubl.
Estuary	1974	Feb	19	3	Gnd	Trethewey unpubl.
Estuary	1974	Feb	27	0	Gnd	Trethewey unpubl.
Estuary	1974	Mar	06	0	Gnd	Trethewey unpubl.
Estuary	1974	Mar	13	2	Gnd	Trethewey unpubl.
Estuary	1974	Mar	21	0	Gnd	Trethewey unpubl.
Estuary	1974	Mar	27	4	Gnd	Trethewey unpubl.
Estuary	1974	Dec	10	3	Gnd	Trethewey unpubl.

App. 2. ctd'd.

AREA	YEAR	MONTH	DAY	NUMBER OBSERVED	SURVEY TYPE[1]	SOURCE
Campbell River:						
Estuary	1974	Dec	18	0	Gnd	Trethewey unpubl.
Estuary	1975	Jan	02	0	Gnd	Trethewey unpubl.
Estuary	1975	Jan	07	0	Gnd	Trethewey unpubl.
Estuary	1975	Jan	14	0	Gnd	Trethewey unpubl.
Estuary	1975	Jan	21	0	Gnd	Trethewey unpubl.
Estuary	1975	Jan	28	1	Gnd	Trethewey unpubl.
Estuary	1975	Feb	05	0	Gnd	Trethewey unpubl.
Estuary	1975	Feb	20	0	Gnd	Trethewey unpubl.
Estuary	1975	Feb	27	0	Gnd	Trethewey unpubl.
Estuary	1975	Mar	05	0	Gnd	Trethewey unpubl.
Estuary	1975	Mar	12	4	Gnd	Trethewey unpubl.
Estuary	1975	Mar	19	0	Gnd	Trethewey unpubl.
Estuary	1975	Mar	27	0	Gnd	Trethewey unpubl.
Estuary	1975	Apr	01	0	Gnd	Trethewey unpubl.
Estuary	1975	Apr	10	2	Gnd	Trethewey unpubl.
Estuary	1975	Apr	16	4	Gnd	Trethewey unpubl.
Estuary	1975	Apr	24	5	Gnd	Trethewey unpubl.
Estuary	1975	Apr	30	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Jan	18	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Jan	22	2	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Jan	29	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Feb	07	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Feb	13	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Feb	13	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Feb	19	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Feb	27	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Mar	07	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Mar	12	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Mar	12	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Mar	19	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Mar	26	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1973	Apr	12	1	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Jan	09	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Jan	17	2	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Jan	24	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Feb	05	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Feb	14	2	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Feb	19	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Feb	28	2	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Mar	06	8	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Mar	13	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Mar	20	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Mar	26	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Dec	01	4	Gnd	Trethewey unpubl.
Nanoose Harbour	1974	Dec	12	3	Gnd	Trethewey unpubl.

App. 2. ctd'd.

AREA	YEAR	MONTH	DAY	NUMBER OBSERVED	SURVEY TYPE[1]	SOURCE
Nanoose Harbour	1974	Dec	17	2	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Jan	02	5	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Jan	07	6	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Jan	14	2	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Jan	21	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Jan	28	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Feb	05	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Feb	12	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Feb	19	2	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Feb	26	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Mar	04	11	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Mar	11	20	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Mar	18	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Mar	26	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Apr	01	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Apr	10	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Apr	16	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Apr	23	0	Gnd	Trethewey unpubl.
Nanoose Harbour	1975	Apr	30	0	Gnd	Trethewey unpubl.
Oyster River:						
Estuary	1973	Jan	19	14	Gnd	Trethewey unpubl.
Estuary	1973	Jan	31	0	Gnd	Trethewey unpubl.
Estuary	1973	Feb	15	12	Gnd	Trethewey unpubl.
Estuary	1973	Feb	28	12	Gnd	Trethewey unpubl.
Estuary	1973	Mar	21	0	Gnd	Trethewey unpubl.
Estuary	1973	Mar	28	0	Gnd	Trethewey unpubl.
Estuary	1973	Apr	17	17	Gnd	Trethewey unpubl.
Estuary	1974	Dec	10	0	Gnd	Trethewey unpubl.
Estuary	1974	Dec	18	43	Gnd	Trethewey unpubl.
Estuary	1975	Jan	02	8	Gnd	Trethewey unpubl.
Estuary	1975	Jan	07	0	Gnd	Trethewey unpubl.
Estuary	1975	Jan	14	13	Gnd	Trethewey unpubl.
Estuary	1975	Jan	21	9	Gnd	Trethewey unpubl.
Estuary	1975	Jan	28	24	Gnd	Trethewey unpubl.
Estuary	1975	Feb	05	13	Gnd	Trethewey unpubl.
Estuary	1975	Feb	20	0	Gnd	Trethewey unpubl.
Estuary	1975	Feb	27	29	Gnd	Trethewey unpubl.
Estuary	1975	Mar	05	8	Gnd	Trethewey unpubl.
Estuary	1975	Mar	12	26	Gnd	Trethewey unpubl.
Estuary	1975	Mar	19	33	Gnd	Trethewey unpubl.
Estuary	1975	Mar	27	5	Gnd	Trethewey unpubl.
Estuary	1975	Apr	01	5	Gnd	Trethewey unpubl.
Estuary	1975	Apr	10	8	Gnd	Trethewey unpubl.
Estuary	1975	Apr	16	0	Gnd	Trethewey unpubl.
Estuary	1975	Apr	23	6	Gnd	Trethewey unpubl.

App. 2. ctd'd.

AREA	YEAR	MONTH	DAY	NUMBER OBSERVED	SURVEY TYPE[1]	SOURCE
Estuary	1975	Apr	30	2	Gnd	Trethewey unpubl.
Big Qualicum:						
Estuary	1973	Jan	18	0	Gnd	Trethewey 1982
Estuary	1973	Jan	23	0	Gnd	Trethewey 1982
Estuary	1973	Feb	07	3	Gnd	Trethewey 1982
Estuary	1973	Feb	13	0	Gnd	Trethewey 1982
Estuary	1973	Feb	20	5	Gnd	Trethewey 1982
Estuary	1973	Mar	08	2	Gnd	Trethewey 1982
Estuary	1974	Mar	13	0	Gnd	Trethewey 1982
Estuary	1973	Mar	20	36	Gnd	Trethewey 1982
Estuary	1973	Mar	27	43	Gnd	Trethewey 1982
Estuary	1974	Jan	17	2	Gnd	Trethewey 1982
Estuary	1974	Jan	24	2	Gnd	Trethewey 1982
Estuary	1974	Jan	29	4	Gnd	Trethewey 1982
Estuary	1974	Feb	06	4	Gnd	Trethewey 1982
Estuary	1974	Feb	13	6	Gnd	Trethewey 1982
Estuary	1974	Feb	20	0	Gnd	Trethewey 1982
Estuary	1974	Feb	28	0	Gnd	Trethewey 1982
Estuary	1974	Mar	06	13	Gnd	Trethewey 1982
Estuary	1974	Mar	13	2	Gnd	Trethewey 1982
Estuary	1974	Mar	21	6	Gnd	Trethewey 1982
Estuary	1974	Mar	27	2	Gnd	Trethewey 1982
Estuary	1974	Dec	19	0	Gnd	Trethewey 1982
Estuary	1975	Jan	02	0	Gnd	Trethewey 1982
Estuary	1975	Jan	07	0	Gnd	Trethewey 1982
Estuary	1975	Jan	14	0	Gnd	Trethewey 1982
Estuary	1975	Jan	21	0	Gnd	Trethewey 1982
Estuary	1975	Jan	29	0	Gnd	Trethewey 1982
Estuary	1975	Feb	05	0	Gnd	Trethewey 1982
Estuary	1975	Feb	19	0	Gnd	Trethewey 1982
Estuary	1975	Feb	26	0	Gnd	Trethewey 1982
Estuary	1975	Mar	04	0	Gnd	Trethewey 1982
Estuary	1975	Mar	11	2	Gnd	Trethewey 1982
Estuary	1975	Mar	18	0	Gnd	Trethewey 1982
Estuary	1975	Mar	27	4	Gnd	Trethewey 1982
Estuary	1975	Apr	01	28	Gnd	Trethewey 1982
Estuary	1975	Apr	10	15	Gnd	Trethewey 1982
Estuary	1975	Apr	16	0	Gnd	Trethewey 1982
Estuary	1975	Apr	23	17	Gnd	Trethewey 1982
Estuary	1975	Apr	30	14	Gnd	Trethewey 1982

Appendix 3. Christmas Bird Counts of Harlequin Ducks in coastal British Columbia from 1958 to 1988.

AREA	YEAR	NUMBER OBSERVED
Bamfield	1987	21
Campbell River	1973	0
Campbell River	1974	139
Campbell River	1975	20
Campbell River	1976	70
Campbell River	1977	160
Campbell River	1978	105
Campbell River	1979	133
Campbell River	1980	85
Campbell River	1981	126
Campbell River	1982	68
Campbell River	1983	102
Campbell River	1984	204
Campbell River	1985	82
Campbell River	1987	367
Comox	1962	73
Comox	1963	13
Comox	1964	144
Comox	1965	76
Comox	1967	125
Comox	1968	208
Comox	1969	30
Comox	1970	198
Comox	1971	242
Comox	1972	164
Comox	1973	360
Comox	1974	262
Comox	1975	234
Comox	1976	187
Comox	1977	348
Comox	1978	205
Comox	1979	203
Comox	1980	144
Comox	1981	291
Comox	1982	385
Comox	1983	300
Comox	1984	181
Comox	1985	121
Comox	1986	253
Comox	1987	73
Deep Bay	1976	414
Deep Bay	1977	381

Appendix 3. Cont'd.

AREA	YEAR	NUMBER OBSERVED
Deep Bay	1978	366
Deep Bay	1979	311
Deep Bay	1980	287
Deep Bay	1981	435
Deep Bay	1982	429
Deep Bay	1983	886
Deep Bay	1984	297
Deep Bay	1985	255
Deep Bay	1986	297
Deep Bay	1987	147
Duncan	1971	0
Duncan	1972	0
Duncan	1973	0
Duncan	1974	0
Duncan	1975	0
Duncan	1976	0
Duncan	1977	0
Duncan	1978	0
Duncan	1979	1
Duncan	1980	0
Duncan	1981	3
Duncan	1982	0
Duncan	1983	0
Duncan	1984	0
Duncan	1985	0
Kitimat	1987	2
Ladner	1958	0
Ladner	1959	15
Ladner	1960	17
Ladner	1961	7
Ladner	1962	10
Ladner	1963	37
Ladner	1964	27
Ladner	1965	8
Ladner	1966	0
Ladner	1969	111
Ladner	1970	25
Ladner	1971	56
Ladner	1972	46
Ladner	1973	32
Ladner	1974	55
Ladner	1975	65
Ladner	1976	43
Ladner	1977	29

Appendix 3. Cont'd.

AREA	YEAR	NUMBER OBSERVED
Ladner	1979	24
Ladner	1980	100
Ladner	1981	136
Ladner	1982	114
Ladner	1983	59
Ladner	1984	62
Ladner	1985	60
Ladner	1986	117
Ladner	1987	49
Masset	1983	141
Masset	1984	56
Masset	1985	16
Masset	1986	27
Masset	1987	22
Nanaimo	1964	20
Nanaimo	1965	13
Nanaimo	1966	0
Nanaimo	1967	6
Nanaimo	1968	19
Nanaimo	1969	13
Nanaimo	1973	20
Nanaimo	1974	17
Nanaimo	1975	48
Nanaimo	1976	39
Nanaimo	1977	50
Nanaimo	1978	72
Nanaimo	1979	43
Nanaimo	1980	32
Nanaimo	1981	67
Nanaimo	1982	65
Nanaimo	1983	54
Nanaimo	1984	47
Nanaimo	1985	20
Nanaimo	1986	15
Nanaimo	1987	23
Port Clemens	1987	1
Penticton	1975	0
Penticton	1976	0
Penticton	1977	0
Penticton	1979	1
Penticton	1981	0
Penticton	1982	0
Penticton	1983	0

Appendix 3. Cont'd.

AREA	YEAR	NUMBER OBSERVED
Penticton	1984	0
Penticton	1985	1
Pender Islands	1965	0
Pender Islands	1966	0
Pender Islands	1967	18
Pender Islands	1971	30
Pender Islands	1972	23
Pender Islands	1973	57
Pender Islands	1974	28
Pender Islands	1975	37
Pender Islands	1976	47
Pender Islands	1977	58
Pender Islands	1978	48
Pender Islands	1979	26
Pender Islands	1980	43
Pender Islands	1981	33
Pender Islands	1982	14
Pender Islands	1983	16
Pender Islands	1984	9
Pender Islands	1985	91
Pender Islands	1986	138
Pender Islands	1987	35
Prince Rupert	1987	4
Revelstoke	1987	5
Rose Spit	1987	7
Sayward	1974	0
Sayward	1975	0
Sayward	1976	0
Sayward	1977	0
Sayward	1978	0
Sayward	1979	0
Sayward	1980	1
Sayward	1981	0
Sayward	1982	0
Sayward	1983	0
Sayward	1984	0
Sayward	1985	1
Sunshine coast	1980	16
Sunshine Coast	1981	56
Sunshine Coast	1982	76
Sunshine Coast	1983	14

Appendix 3. Cont'd.

AREA	YEAR	NUMBER OBSERVED
Sunshine Coast	1984	38
Sunshine Coast	1985	64
Sunshine Coast	1987	50
Skidegate Inlet	1983	69
Skidegate Inlet	1984	94
Skidegate Inlet	1985	64
Skidegate Inlet	1986	282
Skidegate Inlet	1987	56
San Juan WA - Sidney BC	1983	45
San Juan WA - Sidney BC	1984	58
San Juan Wa - Sidney BC	1985	50
San Juan Wa - Sidney BC	1986	4
San Juan Wa - Sidney BC	1986	112
San Juan Wa - Sidney BC	1987	92
Sooke	1984	49
Sooke	1985	7
Sooke	1986	38
Sooke	1987	42
Squamish	1981	1
Squamish	1982	0
Squamish	1983	0
Squamish	1984	0
Squamish	1985	0
Squamish	1987	1
Vancouver	1958	13
Vancouver	1959	25
Vancouver	1960	10
Vancouver	1961	3
Vancouver	1962	7
Vancouver	1963	0
Vancouver	1964	3
Vancouver	1965	0
Vancouver	1966	9
Vancouver	1967	7
Vancouver	1968	23
Vancouver	1969	10
Vancouver	1970	36
Vancouver	1971	35
Vancouver	1972	33
Vancouver	1973	39
Vancouver	1974	19
Vancouver	1975	23

Appendix 3. Cont'd.

AREA	YEAR	NUMBER OBSERVED
Vancouver	1976	34
Vancouver	1977	12
Vancouver	1978	27
Vancouver	1979	26
Vancouver	1980	43
Vancouver	1981	46
Vancouver	1982	48
Vancouver	1983	39
Vancouver	1984	37
Vancouver	1985	49
Vancouver	1986	66
Vancouver	1987	51
Victoria	1959	107
Victoria	1960	83
Victoria	1961	120
Victoria	1962	240
Victoria	1963	280
Victoria	1964	306
Victoria	1965	417
Victoria	1966	412
Victoria	1967	248
Victoria	1968	195
Victoria	1969	191
Victoria	1970	229
Victoria	1971	150
Victoria	1972	104
Victoria	1973	211
Victoria	1974	260
Victoria	1975	85
Victoria	1976	296
Victoria	1977	204
Victoria	1978	305
Victoria	1979	82
Victoria	1980	137
Victoria	1981	318
Victoria	1982	194
Victoria	1983	151
Victoria	1984	220
Victoria	1985	325
Victoria	1986	297
Victoria	1987	280
Vaseux Lake	1975	0
Vaseux Lake	1976	0
Vaseux Lake	1977	1
Vaseux Lake	1978	0

Appendix 3. Cont'd.

AREA	YEAR	NUMBER OBSERVED
Vaseux Lake	1979	1
Vaseux Lake	1980	0
Vaseux Lake	1981	0
Vaseux Lake	1982	0
Vaseux Lake	1983	1
Vaseux Lake	1984	2
Vaseux Lake	1985	0
White Rock	1961	2
White Rock	1962	8
White Rock	1963	3
White Rock	1964	17
White Rock	1965	0
White Rock	1966	0
White Rock	1967	1
White Rock	1972	10
White Rock	1973	32
White Rock	1974	32
White Rock	1975	33
White Rock	1976	247
White Rock	1977	37
White Rock	1978	37
White Rock	1979	144
White Rock	1980	67
White Rock	1981	66
White Rock	1982	42
White Rock	1983	63
White Rock	1984	20
White Rock	1985	32
White Rock	1986	51
White Rock	1987	40

Appendix 4. Harlequin Duck counts from Willemar Bluff to Deep Bay from October 1980 to October 1981.

AREA	YEAR	MONTH	DATE	NUMBER OF HARLEQUINS
Buckley Bay to Union Point	80	Dec	13	33
Buckley Bay to Union Point	80	Nov	01	37
Buckley Bay to Union Point	80	Nov	08	46
Buckley Bay to Union Point	80	Nov	15	49
Buckley Bay to Union Point	80	Nov	23	45
Buckley Bay to Union Point	80	Oct	11	11
Buckley Bay to Union Point	80	Oct	18	25
Buckley Bay to Union Point	80	Oct	25	0
Buckley Bay to Union Point	81	Apr	04	83
Buckley Bay to Union Point	81	Apr	11	39
Buckley Bay to Union Point	81	Apr	25	11
Buckley Bay to Union Point	81	Feb	07	24
Buckley Bay to Union Point	81	Feb	14	36
Buckley Bay to Union Point	81	Feb	21	43
Buckley Bay to Union Point	81	Feb	28	24
Buckley Bay to Union Point	81	Jan	10	40
Buckley Bay to Union Point	81	Jan	17	28
Buckley Bay to Union Point	81	Jan	24	28
Buckley Bay to Union Point	81	Jan	31	10
Buckley Bay to Union Point	81	Jul	18	0
Buckley Bay to Union Point	81	Mar	07	30
Buckley Bay to Union Point	81	Mar	21	8
Buckley Bay to Union Point	81	Mar	28	119
Buckley Bay to Union Point	81	Oct	03	24
Buckley Bay to Union Point	81	Sep	05	0
Buckley Bay to Union Point	81	Sep	12	0
Buckley Bay to Union Point	81	Sep	19	6
Buckley Bay to Union Point	81	Sep	26	7
Buckley Bay to Waterloo Cr	80	Dec	13	18
Buckley Bay to Waterloo Cr	80	Nov	08	28
Buckley Bay to Waterloo Cr	80	Nov	15	6
Buckley Bay to Waterloo Cr	80	Nov	22	85
Buckley Bay to Waterloo Cr	80	Oct	11	26
Buckley Bay to Waterloo Cr	80	Oct	18	49
Buckley Bay to Waterloo Cr	80	Oct	25	49
Buckley Bay to Waterloo Cr	81	Apr	04	16
Buckley Bay to Waterloo Cr	81	Apr	11	14
Buckley Bay to Waterloo Cr	81	Apr	25	21
Buckley Bay to Waterloo Cr	81	Aug	01	0
Buckley Bay to Waterloo Cr	81	Aug	15	0
Buckley Bay to Waterloo Cr	81	Feb	07	33
Buckley Bay to Waterloo Cr	81	Feb	14	39
Buckley Bay to Waterloo Cr	81	Feb	21	13

Appendix 4 (ctd.)

AREA	YEAR	MONTH	DATE	NUMBER OF HARLEQUINS
Buckley Bay to Waterloo Cr	81	Feb	28	32
Buckley Bay to Waterloo Cr	81	Jan	10	24
Buckley Bay to Waterloo Cr	81	Jan	17	36
Buckley Bay to Waterloo Cr	81	Jan	24	15
Buckley Bay to Waterloo Cr	81	Jan	31	48
Buckley Bay to Waterloo Cr	81	Jul	04	0
Buckley Bay to Waterloo Cr	81	Jul	18	0
Buckley Bay to Waterloo Cr	81	Jun	06	8
Buckley Bay to Waterloo Cr	81	Jun	13	26
Buckley Bay to Waterloo Cr	81	Jun	20	2
Buckley Bay to Waterloo Cr	81	Mar	07	28
Buckley Bay to Waterloo Cr	81	Mar	14	30
Buckley Bay to Waterloo Cr	81	Mar	21	50
Buckley Bay to Waterloo Cr	81	Mar	28	17
Buckley Bay to Waterloo Cr	81	May	16	18
Buckley Bay to Waterloo Cr	81	May	23	30
Buckley Bay to Waterloo Cr	81	May	30	8
Buckley Bay to Waterloo Cr	81	Oct	10	47
Buckley Bay to Waterloo Cr	81	Oct	31	69
Buckley Bay to Waterloo Cr	81	Sep	05	42
Buckley Bay to Waterloo Cr	81	Sep	19	56
Buckley Bay to Waterloo Cr	81	Sep	26	115
Comox Bay to sewage lagoon	80	Dec	13	6
Comox Bay to sewage lagoon	80	Nov	01	2
Comox Bay to sewage lagoon	80	Nov	08	0
Comox Bay to sewage lagoon	80	Nov	15	6
Comox Bay to sewage lagoon	80	Nov	22	8
Comox Bay to sewage lagoon	80	Nov	29	0
Comox Bay to sewage lagoon	80	Oct	11	0
Comox Bay to sewage lagoon	80	Oct	18	0
Comox Bay to sewage lagoon	80	Oct	25	0
Comox Bay to sewage lagoon	81	Apr	04	0
Comox Bay to sewage lagoon	81	Apr	11	17
Comox Bay to sewage lagoon	81	Apr	25	51
Comox Bay to sewage lagoon	81	Aug	01	0
Comox Bay to sewage lagoon	81	Aug	08	0
Comox Bay to sewage lagoon	81	Aug	22	0
Comox Bay to sewage lagoon	81	Feb	07	15
Comox Bay to sewage lagoon	81	Feb	14	5
Comox Bay to sewage lagoon	81	Feb	21	13
Comox Bay to sewage lagoon	81	Feb	28	6
Comox Bay to sewage lagoon	81	Jan	10	0
Comox Bay to sewage lagoon	81	Jan	17	0
Comox Bay to sewage lagoon	81	Jan	24	4
Comox Bay to sewage lagoon	81	Jan	31	13
Comox Bay to sewage lagoon	81	Jul	04	0

Appendix 4 (ctd.)

AREA	YEAR	MONTH	DATE	NUMBER OF HARLEQUINS
Comox Bay to sewage lagoon	81	Jul	11	0
Comox Bay to sewage lagoon	81	Jul	18	2
Comox Bay to sewage lagoon	81	Jun	06	39
Comox Bay to sewage lagoon	81	Jun	13	0
Comox Bay to sewage lagoon	81	Jun	20	0
Comox Bay to sewage lagoon	81	Jun	27	0
Comox Bay to sewage lagoon	81	Mar	07	2
Comox Bay to sewage lagoon	81	Mar	14	0
Comox Bay to sewage lagoon	81	Mar	21	0
Comox Bay to sewage lagoon	81	Mar	28	0
Comox Bay to sewage lagoon	81	May	10	33
Comox Bay to sewage lagoon	81	May	16	66
Comox Bay to sewage lagoon	81	May	23	85
Comox Bay to sewage lagoon	81	May	30	0
Comox Bay to sewage lagoon	81	Oct	03	9
Comox Bay to sewage lagoon	81	Oct	10	23
Comox Bay to sewage lagoon	81	Sep	05	0
Comox Bay to sewage lagoon	81	Sep	12	0
Comox Bay to sewage lagoon	81	Sep	19	1
Comox Bay to sewage lagoon	81	Sep	26	0
Deep Bay to Mud Bay	80	Dec	13	28
Deep Bay to Mud Bay	80	Nov	01	78
Deep Bay to Mud Bay	80	Nov	08	56
Deep Bay to Mud Bay	80	Nov	15	69
Deep Bay to Mud Bay	80	Nov	22	62
Deep Bay to Mud Bay	80	Nov	29	43
Deep Bay to Mud Bay	80	Oct	11	50
Deep Bay to Mud Bay	80	Oct	18	20
Deep Bay to Mud Bay	80	Oct	25	64
Deep Bay to Mud Bay	81	Apr	04	38
Deep Bay to Mud Bay	81	Apr	11	29
Deep Bay to Mud Bay	81	Apr	25	6
Deep Bay to Mud Bay	81	Aug	01	0
Deep Bay to Mud Bay	81	Aug	08	0
Deep Bay to Mud Bay	81	Aug	22	6
Deep Bay to Mud Bay	81	Feb	07	29
Deep Bay to Mud Bay	81	Feb	14	26
Deep Bay to Mud Bay	81	Feb	21	19
Deep Bay to Mud Bay	81	Feb	28	27
Deep Bay to Mud Bay	81	Jan	10	52
Deep Bay to Mud Bay	81	Jan	17	66
Deep Bay to Mud Bay	81	Jan	24	57
Deep Bay to Mud Bay	81	Jan	31	36
Deep Bay to Mud Bay	81	Jul	04	0
Deep Bay to Mud Bay	81	Jul	18	0
Deep Bay to Mud Bay	81	Jun	06	26

Appendix 4 (ctd.)

AREA	YEAR	MONTH	DATE	NUMBER OF HARLEQUINS
Deep Bay to Mud Bay	81	Jun	13	0
Deep Bay to Mud Bay	81	Jun	20	12
Deep Bay to Mud Bay	81	Jun	27	0
Deep Bay to Mud Bay	81	Mar	07	25
Deep Bay to Mud Bay	81	Mar	14	39
Deep Bay to Mud Bay	81	Mar	21	28
Deep Bay to Mud Bay	81	Mar	28	34
Deep Bay to Mud Bay	81	May	10	8
Deep Bay to Mud Bay	81	May	16	2
Deep Bay to Mud Bay	81	May	23	8
Deep Bay to Mud Bay	81	May	30	13
Deep Bay to Mud Bay	81	Oct	03	56
Deep Bay to Mud Bay	81	Oct	10	55
Deep Bay to Mud Bay	81	Sep	05	6
Deep Bay to Mud Bay	81	Sep	12	16
Deep Bay to Mud Bay	81	Sep	19	45
Deep Bay to Mud Bay	81	Sep	26	25
Denman Island	80	Dec	06	40
Denman Island	80	Dec	12.13	26
Denman Island	80	Nov	08	39
Denman Island	80	Nov	14.15	41
Denman Island	80	Nov	21.22	50
Denman Island	80	Nov	30	38
Denman Island	80	Oct	11	11
Denman Island	80	Oct	18	37
Denman Island	80	Oct	24.25	63
Denman Island	80	Oct	31.01	26
Denman Island	81	Apr	05	4
Denman Island	81	Apr	11	20
Denman Island	81	Apr	17.19	24
Denman Island	81	Apr	24.25	8
Denman Island	81	Feb	07	47
Denman Island	81	Feb	21.22	77
Denman Island	81	Feb	28	42
Denman Island	81	Jan	10	89
Denman Island	81	Jan	18	117
Denman Island	81	Jan	25	71
Denman Island	81	Jan	31	61
Denman Island	81	Mar	07	6
Denman Island	81	Mar	14	8
Denman Island	81	Mar	21	12
Denman Island	81	Mar	29	46
Denman Island	81	May	10	2
Goose Spit - Willemar Bluff	80	Dec	13	12
Goose Spit - Willemar Bluff	80	Nov	01	20
Goose Spit - Willemar Bluff	80	Nov	08	17

Appendix 4 (ctd.)

AREA	YEAR	MONTH	DATE	NUMBER OF HARLEQUINS
Goose Spit - Willemar Bluff	80	Nov	15	21
Goose Spit - Willemar Bluff	80	Nov	22	23
Goose Spit - Willemar Bluff	80	Nov	29	24
Goose Spit - Willemar Bluff	80	Oct	11	13
Goose Spit - Willemar Bluff	80	Oct	18	2
Goose Spit - Willemar Bluff	80	Oct	25	3
Goose Spit - Willemar Bluff	81	Apr	04	4
Goose Spit - Willemar Bluff	81	Apr	11	31
Goose Spit - Willemar Bluff	81	Apr	25	9
Goose Spit - Willemar Bluff	81	Aug	01	0
Goose Spit - Willemar Bluff	81	Aug	15	0
Goose Spit - Willemar Bluff	81	Feb	21	33
Goose Spit - Willemar Bluff	81	Feb	28	22
Goose Spit - Willemar Bluff	81	Feb	7	22
Goose Spit - Willemar Bluff	81	Jan	10	9
Goose Spit - Willemar Bluff	81	Jan	17	33
Goose Spit - Willemar Bluff	81	Jan	24	17
Goose Spit - Willemar Bluff	81	Jan	31	42
Goose Spit - Willemar Bluff	81	Jul	04	0
Goose Spit - Willemar Bluff	81	Jul	18	0
Goose Spit - Willemar Bluff	81	Jun	13	0
Goose Spit - Willemar Bluff	81	Mar	14	32
Goose Spit - Willemar Bluff	81	Mar	21	30
Goose Spit - Willemar Bluff	81	Mar	28	8
Goose Spit - Willemar Bluff	81	Mar	7	4
Goose Spit - Willemar Bluff	81	May	10	13
Goose Spit - Willemar Bluff	81	May	16	18
Goose Spit - Willemar Bluff	81	May	23	14
Goose Spit - Willemar Bluff	81	May	30	12
Goose Spit - Willemar Bluff	81	Oct	03	90
Goose Spit - Willemar Bluff	81	Oct	10	35
Goose Spit - Willemar Bluff	81	Sep	04	29
Goose Spit - Willemar Bluff	81	Sep	19	31
Mansfield Drive to Union Bay	80	Dec	13	10
Mansfield Drive to Union Bay	80	Nov	01	27
Mansfield Drive to Union Bay	80	Nov	08	7
Mansfield Drive to Union Bay	80	Nov	15	28
Mansfield Drive to Union Bay	80	Nov	22	19
Mansfield Drive to Union Bay	80	Nov	29	4
Mansfield Drive to Union Bay	80	Oct	11	0
Mansfield Drive to Union Bay	80	Oct	18	64
Mansfield Drive to Union Bay	80	Oct	25	22
Mansfield Drive to Union Bay	81	Apr	04	0
Mansfield Drive to Union Bay	81	Apr	11	2
Mansfield Drive to Union Bay	81	Apr	25	0
Mansfield Drive to Union Bay	81	Aug	01	0

Appendix 4 (ctd.)

AREA	YEAR	MONTH	DATE	NUMBER OF HARLEQUINS
Mansfield Drive to Union Bay	81	Aug	08	0
Mansfield Drive to Union Bay	81	Aug	15	0
Mansfield Drive to Union Bay	81	Aug	22	0
Mansfield Drive to Union Bay	81	Feb	07	0
Mansfield Drive to Union Bay	81	Feb	14	0
Mansfield Drive to Union Bay	81	Feb	21	0
Mansfield Drive to Union Bay	81	Feb	28	0
Mansfield Drive to Union Bay	81	Jan	10	17
Mansfield Drive to Union Bay	81	Jan	17	6
Mansfield Drive to Union Bay	81	Jan	24	0
Mansfield Drive to Union Bay	81	Jan	31	0
Mansfield Drive to Union Bay	81	Jul	04	0
Mansfield Drive to Union Bay	81	Jul	11	0
Mansfield Drive to Union Bay	81	Jul	18	0
Mansfield Drive to Union Bay	81	Jul	25	0
Mansfield Drive to Union Bay	81	Jun	06	0
Mansfield Drive to Union Bay	81	Jun	13	0
Mansfield Drive to Union Bay	81	Jun	20	0
Mansfield Drive to Union Bay	81	Jun	27	0
Mansfield Drive to Union Bay	81	Mar	07	0
Mansfield Drive to Union Bay	81	Mar	14	0
Mansfield Drive to Union Bay	81	Mar	21	0
Mansfield Drive to Union Bay	81	Mar	28	0
Mansfield Drive to Union Bay	81	May	10	0
Mansfield Drive to Union Bay	81	May	16	0
Mansfield Drive to Union Bay	81	May	23	0
Mansfield Drive to Union Bay	81	May	30	0
Mansfield Drive to Union Bay	81	Oct	03	5
Mansfield Drive to Union Bay	81	Oct	10	0
Mansfield Drive to Union Bay	81	Sep	05	0
Mansfield Drive to Union Bay	81	Sep	12	0
Mansfield Drive to Union Bay	81	Sep	19	0
Mansfield Drive to Union Bay	81	Sep	26	0
Union Point to Gartley Beach	81	Apr	04	19
Union Point to Gartley Beach	81	Apr	11	51
Union Point to Gartley Beach	81	Apr	25	24
Union Point to Gartley Beach	81	Aug	01	0
Union Point to Gartley Beach	81	Aug	08	5
Union Point to Gartley Beach	81	Aug	15	0
Union Point to Gartley Beach	81	Aug	22	0
Union Point to Gartley Beach	81	Feb	07	23
Union Point to Gartley Beach	81	Feb	14	15
Union Point to Gartley Beach	81	Feb	21	29
Union Point to Gartley Beach	81	Feb	28	20
Union Point to Gartley Beach	81	Jan	24	22

Appendix 4 (ctd.)

AREA	YEAR	MONTH	DATE	NUMBER OF HARLEQUINS
Union Point to Gartley Beach	81	Jan	31	37
Union Point to Gartley Beach	81	Jul	04	0
Union Point to Gartley Beach	81	Jul	11	0
Union Point to Gartley Beach	81	Jul	25	0
Union Point to Gartley Beach	81	Jun	06	0
Union Point to Gartley Beach	81	Jun	13	0
Union Point to Gartley Beach	81	Jun	20	0
Union Point to Gartley Beach	81	Jun	27	0
Union Point to Gartley Beach	81	Mar	07	12
Union Point to Gartley Beach	81	Mar	14	22
Union Point to Gartley Beach	81	Mar	16	5
Union Point to Gartley Beach	81	Mar	21	153
Union Point to Gartley Beach	81	Mar	23	0
Union Point to Gartley Beach	81	Mar	28	163
Union Point to Gartley Beach	81	Mar	30	0
Union Point to Gartley Beach	81	May	10	19
Union Point to Gartley Beach	81	Oct	03	15
Union Point to Gartley Beach	81	Oct	10	12
Union Point to Gartley Beach	81	Sep	05	3
Union Point to Gartley Beach	81	Sep	12	0
Union Point to Gartley Beach	81	Sep	19	15
Union Point to Gartley Beach	81	Sep	26	32

Appendix 5. Confirmed breeding records of Harlequin Ducks in British Columbia.

TOPO MAP	LOCATION[1]	YEAR	DATE	RECORD	ALTITUDE (m)	SOURCE[2]
82 E/5	Penticton	1936	Jul 6	F + B	Unkn	BCNRS
82 E/5	Sheep Creek, 6mi SW	1936	May 24	7 E	600	BCNRS
82 E/5	Shingle Creek	1947	Jun 1	F + 6 E	400-900	BCNRS
82 E/5	Shingle Creek	1937	Jul 7	F + 5 Y	400-900	BCNRS
82 K/9	KNP, McKay Cr	1963	Summer	F + 5 Y	1080-2100	Seel 1965
82 K/9	Glacial lake in Purcell Mts			B	Unkn	KNP
82 N/4	GNP, Flat Cr	1942	Jun	4 Y	900-1560	BCNRS
82 N/5	GNP, Illicillewact Riv. near Glacier	1942	Jul 20	F + B	1110	BCNRS
82 N/7	YNP, Amiskwi River	1975	Jul 26	7 Y	1500-1560	BCNRS
82 N/8,9	YNP, Little Yoho Riv. Valley	1962	Jul 25	3 Y	1950	BCNRS
83 E/3	MRPP, stream near Berg Lake	1974	Aug 1,3	F + 4 Y	1610	BCNRS
92 B/6	Victoria	1968	Jun 23	A + Y	Sea level	BCNRS
92 C/14	Baeria Rocks Ecol. Res.	1969	Aug 13	Downy Y	Sea level	BCNRS
92 F/10	Point Lazo	1943	Jul 12	F + 4 Y	Sea level	BCNRS

ABBREVIATIONS:
A= Adult B= Brood E= Egg F= Female Y= Young

1 KNP= Kootenay National Park
MRPP= Mount Robson Provincial Park
GNP= Glacier National Park
YNP= Yoho National Park

2 BCNRS= British Columbia Nest Record Scheme
KNP= Poll *et al.* 1984

Appendix 5. Cont'd.

TOPO MAP	LOCATION[1]	YEAR	DATE	RECORD	ALTITUDE (m)	SOURCE[2]
92 G/7	Coquitlam Riv	1979	Jun 22	F + 4 Y	120	BCNRS
92 H/1	Ashnola Riv., Keremeos	1969	Jun 22	3 Y	900	BCNRS
92 H/2	MP, Similkameen Riv.	1984	Jun 21	F + 5 Y	1000	BCNRS
92 H/2	Skagit River W of MP on HWY 3	1985	Jun 26	F + 4 Y	Unkn	Unknown
92 H/3	MP, Similkameen Riv.	1969	Jun 25	5 Y	1080	BCNRS
92 H/3,6	MP, Sumallo Riv.	1984	Jun 17	F + 4 Y	630	BCNRS
92 H/3	Skagit River	1987	Jul 7	F + 3 Y	570	BCNRS
92 H/3	Skagit River	1986	Jun 18	F + 3 Y	450	BCNRS
92 H/3	MP, Sumallo River	1949	Jul 19	F + 6 Y	630	BCNRS
92 H/5,11	Emory Creek	1966	Jun 16	F + 1 Y	30-1000	BCNRS
92 H/6 or H/10	Coquihalla River, 2km Kawkawa Rd	1989	Jul	6 F + 5 Y	Unkn	R.Butler
92 H/8	Similkameen River	1980	Jun 27	F + 5 Y	510-570	BCNRS
	Similkameen River	1986	Jul 27	F + 2 Y	570	BCNRS

ABBREVIATIONS:
B= Brood F= Female Y= Young

1 KNP= Kootenay National Park
MP= Manning Park

2 BCNRS= British Columbia Nest Record Scheme
KNP= Poll *et al.* 1984

Appendix 5 Cont'd.

TOPO MAP	LOCATION[1]	YEAR	DATE	RECORD	ALTITUDE (m)	SOURCE[2]
92 I/2,3 I/6	Nicola River	1950	Jul 23	F + 3 Y	210-570	BCNRS
92 J/14	Drainage into Leckie Lake, Wolverine Pass	1987	Aug 18	F + 3 Y	2175	M. Lemon
92 J/14	Small lake E of Leckie Lakes	1987	Aug 18	F + 1 Y	2025	M. Lemon
92 K/9	KNP,Sinclair Creek		Summer	3-5 Y B	Unkn	KNP
94 E/4	SPWPP, Stream near Duti Lakes	1976	Aug 2	F + 10 Y	1250-2000	BCNRS
94 E/5	Duti Lake North	1976	Aug 5	A + 8 Y	1250	BCNRS
94 K/10	McDonald Ck, Mile 114 N on Alaska Hwy	1944	Jul 21	Downy Y	870	BCNRS
103 C/16	Moresby Lake	1983	Jun	F + 5 Y	310	BCNRS
103 F/9	Kwaikans Is	1986	Jun 24	4 E + 2 Y	2	BCNRS
104 O/4,5 N/8	Teslin River	1982	Aug 4	F + 8 Y	680-770	BCNRS

ABBREVIATIONS:
A= Adult E= Egg F= Female Y= Young

1 SPWPP= Spatsizi Plateau Wilderness Provincial Park

2 BCNRS= British Columbia Nest Record Scheme

Appendix 6. Unconfirmed breeding records of Harlequin Ducks in British Columbia.

TOPO MAP	LOCATION[1]	YEAR	DATE	RECORD	ALTITUDE (m)	SOURCE[2]
82 E/5	Shingle Creek	1982	Aug 4	2 Y	850	BCNRS
82 F/15	Lake at E Fork of Bernard Cr	1980	Aug 22	F + 5 Y	2040	BCNRS
82 G/10	Alexander Cr	1969	Aug 20	4 Y	1290	BCNRS
82 K/3	Creek 10 mi NE of Roseberry	1980	Aug 19	5 Y	930-1800	BCNRS
82 L/12	Shuswap River at Cherryville	1973	Aug 12	5 Y	510	BCNRS
82 N/8	YNP, Wapta Lk	1922	Aug 29	5 F or Y	1560	BCNRS
82 N/8	YNP, O'Hara Lk	1962	Aug 10	4 Y	1980	BCNRS
82 N/8	YNP, O'Hara Lk	1975	Aug 12	1 Y	1980	BCNRS
82 N/8	YNP, O'Hara Lk	1976	Sep 13	F + 5 Y	1980	BCNRS
92 B/14	Wise Island	1939	Aug 17	3 x F + B	Sea level	BCNRS
92 G/5	Gibsons Hbr	1987	Aug 25	A + 5 Y	Sea level	BCNRS
92 H/3	Silverhope Cr	1986	Aug 25	3 Y	450	BCNRS
92 L/3	Sally Creek	Unkn	Aug 17	F + 4 Y	90	BCNRS
92 P/16	Hemp Creek	1950	Aug 6	3 Y	480-570	BCNRS
94 E/5	SPWPP, Stikine River at Laslui Lk	1975	Aug 3	4 Y	1200	BCNRS
104 N/14	Consolation Cr near Gladys Lk	1926	Sep 7	B	>870	BCNRS

ABBREVIATIONS:
A= Adult B= Brood F= Female Y= Young

1 SPWPP= Spatsizi Plateau Wilderness Provincial Park
YNP= Yoho National Park

2 BCNRS= British Columbia Nest Record Scheme

Appendix 7. Areas with counts of at least 100 Harlequin Ducks in British Columbia (excluding Christmas Bird Counts).

TOPO MAP NUMBER	LOCATION	DATE	NUMBER OBSERVED	SOURCE[1]
92 B/5, C/8-11,14	SW Coast of Vancouver Island	23 Jan 1980	150	MWFI*
92 B/5,6, 11,12	Saanich Peninsula	2,4 Oct 1962	140	MWFI*
	Saanich Peninsula	16 Oct 1962	140	MWFI*
	Saanich Peninsula	12 Jan 1976	113	MWFI**
92 B/6	Chain Islets	19 Jul 1976	110	BCNRS
	Chain, Chatham and Discovery Islands	2 Jul 1984	110	BCNRS
	Chatham and Discovery Islands	27 Dec 1964	258	BCNRS
	Discovery Island	15 Sep 1962	150	BCNRS
	Discovery Island	26 Sep 1959	300	BCNRS
	Oak Bay	28 Oct 1977	108	BCNRS
	Strongtide I	9 Jul 1953	125	BCNRS
	Victoria	11 Jan 1970	117	BCNRS
	Victoria	1 Jan 1972	104	BCNRS
92 B/11	Mandarte Island	mid-June 1977	150	BCNRS
	Portland Island	29 Sep 1984	161	BCNRS
	Saanich Peninsula	30 Oct 1962	180	BCNRS
	Saanich Peninsula	16 Oct 1962	275	BCNRS
	Saanich Peninsula	14 Nov 1962	145	BCNRS
92 F/4	La Croix Group	19 Jun 1975	116	BCNRS
92 F/7	Bowser	26 Mar 1975	778	BCNRS
	Norris Rocks	4 Jun 1978	150	BCNRS
92 F/7,8, 10,15	Nanaimo to Comox	11 Mar 1980	157	MWFI*
92 F/7,10	Buckley Bay to Waterloo Creek	26 Sep 1981	115	Treth
	Denman Island	18 Jan 1981	117	Treth
92 F/8	Qualicum area	10 Mar 1931	100	BCNRS
	Qualicum area	31 Mar 1978	130	BCNRS
	Qualicum area	30 Mar 1978	123	BCNRS
	Qualicum area	30 Mar 1977	100	BCNRS
	Qualicum area	25 Mar 1934	100	BCNRS
	Qualicum area	29 Mar 1976	100	BCNRS
	Qualicum area	5 Apr 1976	102	BCNRS
	Qualicum area	2 Apr 1978	127	BCNRS

1 *= Aerial Survey
**= Boat Survey
MWFI= Mid-Winter Flight Inventory
BCNRS= British Columbia Nest Record Scheme
Treth= Don Trethewey, unpubl. survey

App. 7. ctd.

TOPO MAP NUMBER	LOCATION	DATE	NUMBER OBSERVED	SOURCE[1]
92 F/10	Buckley Bay to Union Point	28 Mar 1981	119	Treth
	Cape Lazo	24 Aug 1963	150	BCNRS
	Cape Lazo	Aug 1943	300	BCNRS
	Comox	11 Sep 1983	120	BCNRS
	Comox	27 Dec 1969	198	BCNRS
	E side Denman Island	15 Mar 1981	200	BCNRS
	Flora Islets	1 Jul 1977	120	BCNRS
	Union Point to Gartley Beach	21 Mar 1981	153	Treth
92 F/10,14 K/3	Cape Lazo to Campbell River	29 Jan 1980	165	MWFI*
	Cape Lazo to Campbell River	11 Mar 1980	119	MWFI*
	Cape Lazo to Campbell River	25 Mar 1980	117	MWFI*
92 G/4	Danger Reefs	16 Jun 1977	109	BCNRS
	Ragget Islets	16 Jun 1977	119	BCNRS
92 G/5	Merry Island	9 Jun 1978	125+	BCNRS
92 G/6	Maplewood Flats	2 Aug 1982	120	BCNRS
92 K/3	Campbell River	14 Aug 1921	150+	BCNRS
	Campbell River	1 Oct 1962	100	BCNRS
	Campbell River	17 Aug 1973	125	BCNRS
	16km S of Campbell River	7 Jul 1977	108+	BCNRS
	Marina Island	29 Mar 1977	150	BCNRS
	Mitlenatch Island	7 Jun 1964	220+	BCNRS
	Mitlenatch Island	19 Jun 1970	179	BCNRS
	Mitlenatch Island	26 Jun 1966	250+	BCNRS
	Mitlenatch Island	14 Jun 1966	250+	BCNRS
	Mitlenatch Island	12 Jun 1966	250+	BCNRS
	Mitlenatch Island	10 Jun 1966	100	BCNRS
	Mitlenatch Island	8 Jun 1966	100	BCNRS
	Mitlenatch Island	29 Jun 1974	100	BCNRS
	Mitlenatch Island	26 Jun 1976	110	BCNRS
	Mitlenatch Island	28 Jun 1965	150	BCNRS
	Mitlenatch Island	27 Jun 1965	150	BCNRS
	Mitlenatch Island	25 Jun 1965	300	BCNRS
	Mitlenatch Island	4 Jun 1964	220	BCNRS
	Mitlenatch Island	1 Jul 1967	300	BCNRS

1 *= Aerial Survey
MWFI= Mid-Winter Flight Inventory
BCNRS= British Columbia Nest Record Scheme
Treth= Don Trethewey, unpubl. survey

App. 7. ctd.

TOPO MAP NUMBER	LOCATION	DATE	NUMBER OBSERVED	SOURCE[1]
92 K/3	Mitlenatch Island	19 Jul 1965	300	BCNRS
	Mitlenatch Island	21 Jul 1975	220	BCNRS
	Mitlenatch Island	29 Jul 1974	100+	BCNRS
	Mitlenatch Island	5 Jul 1963	404	BCNRS
	Mitlenatch Island	7 Jul 1963	150	BCNRS
	Mitlenatch Island	17 Jul 1974	158	BCNRS
	Mitlenatch Island	1 Jul 1978	119	BCNRS
	Mitlenatch Island	7 Jul 1965	130+	BCNRS
	Mitlenatch Island	2 Jul 1970	200	BCNRS
	Mitlenatch Island	9 Jul 1969	150	BCNRS
	Mitlenatch Island	6 Jul 1966	200+	BCNRS
	Mitlenatch Island	20 Jul 1966	150+	BCNRS
	Mitlenatch Island	10 Jul 1971	150+	BCNRS
	Mitlenatch Island	10 Jul 1973	202	BCNRS
	Mitlenatch Island	2 Jul 1977	127	BCNRS
	Mitlenatch Island	1 Jul 1964	100+	BCNRS
	Mitlenatch Island	9 Jul 1964	200+	BCNRS
	Mitlenatch Island	7 Jul 1964	170	BCNRS
	Mitlenatch Island	7 Jul 1964	150	BCNRS
	Mitlenatch Island	4 Jul 1964	100+	BCNRS
	Mitlenatch Island	6 Jul 1966	300	BCNRS
	Mitlenatch Island	20 Jul 1966	150+	BCNRS
	Mitlenatch Island	6 Jul 1974	100	BCNRS
	Mitlenatch Island	17 Jul 1974	158	BCNRS
	Mitlenatch Island	24 May 1963	187	BCNRS
	Mitlenatch Island	26 May 1963	155	BCNRS
	Mitlenatch Island	17 Jun 1970	150	BCNRS
	Mitlenatch Island	1 Jun 1963	210	BCNRS
	Mitlenatch Island	5 Jun 1963	384	BCNRS
	Mitlenatch Island	28 Jun 1970	109	BCNRS
	Mitlenatch Island	16 Jun 1970	106	BCNRS
	Mitlenatch Island	6 Jun 1970	125	BCNRS
	Mitlenatch Island	23 Jun 1969	110	BCNRS
	Mitlenatch Island	30 Jun 1969	110	BCNRS
	Mitlenatch Island	29-30 Jun 1977	110	BCNRS
	Mitlenatch Island	27 Jun 1965	150+	BCNRS
	Mitlenatch Island	25 Jun 1965	300+	BCNRS
	Mitlenatch Island	7 Jun 1964	220+	BCNRS
	Oyster Bay	9 Sep 1977	200+	BCNRS
	Oyster Bay	26 Jun 1973	110	BCNRS
	Oyster Bay	16 Jun 1923	100+	BCNRS
	Oyster Bay	16-17 Aug 1973	100-150	BCNRS
	Oyster River Estuary	7 Jun 1975	100+	BCNRS

1 BCNRS= British Columbia Nest Record Scheme

App. 7. ctd.

TOPO MAP NUMBER	LOCATION	DATE	NUMBER OBSERVED	SOURCE[1]
92 F/15, K/1-3	Parry Passage to Masset Harbor	9 Jan 1978	167	MWFI*
	Parry Passage to Masset Harbor	20 Sep 1979	145	MWFI*
	Parry Passage to Masset Harbor	12 Apr 1980	127	MWFI*
	Parry Passage to Masset Harbour	13 Feb 1978	166	Savard*
	Parry Passage to Masset Harbour	9 Jan 1978	153	Savard*
92 K/3	Shelter and Oyster Bays	26 Aug 1973	200+	BCNRS
	Shelter Bay	13 Aug 1974	100+	BCNRS
	Shelter Bay	11 Aug 1974	150+	BCNRS
	Shelter Bay	18 Aug 1974	100+	BCNRS
	Shelter Bay	20 Sep 1976	175+	BCNRS
	Stories Beach and Shelter Bay	30 Jun 1976	129+	BCNRS
	Stories Beach and Shelter Bay	28 Jul 1976	120+	BCNRS
92 L/13	Storm Islands	13 Jun 1976	116	BCNRS
92 M/4	Off Ruby Rocks	17 Jun 1976	123	BCNRS
	Point Holmes	29 Aug 1955	300	BCNRS
103 B/6	Alder Island	16,23 Apr 1985	255	Rodway**
103 F/15, K/1-3	Parry Passage to Masset Harbor	13 Feb 1978	167	MWFI*
103 G/1,4, 5,8-10, 12	Banks Island to Grenville Channel	18 Oct 1977	109	MWFI*
103 G/4,5	Cumshewa Head to Sandspit	13 Apr 1980	200	MWFI*
103 G/15,16 J/1,2	Porcher Peninsula	24 Sep 1977	215	Savard*
	Porcher Peninsula	18 Oct 1977	135	Savard*
	Porcher Peninsula	10 Jan 1978	126	Savard*
	Porcher Peninsula	15 Feb 1978	125	Savard*
	Chatham Sound and Porcher Peninsula	10 Jan 1981	117	Savard*
	W coast Porcher Isl.	18 Oct 1977	104	Savard*

1 *= Aerial Survey
**= Boat and/or ground survey
MWFI= Mid-Winter Flight Inventory
BCNRS= British Columbia Nest Record Scheme
Rodway= Rodway *et al.* 1988
Savard= Savard 1978a,b,d,e

App. 7. ctd.

TOPO MAP NUMBER	LOCATION	DATE	NUMBER OBSERVED	SOURCE[1]
103 G/15,16 J/1,2	W coast Porcher Isl.	15 Feb 1978	107	Savard*
	W coast Porcher Isl.	10 Jan 1978	102	Savard*
103 G/15,16, H/13 J/1,2,4	Porcher Island and Telegraph Passage	18 Oct 1977	104	MWFI*
	Porcher Island and Telegraph Passage	10 Jan 1978	112	MWFI*
103 H/4, G/7,8,10	W coast Banks I	1 Oct 1977	104	Savard*
	W coast Banks I	24 Sep 1977	123	Savard*
103 J/1	Lawyer's Island	16 Jun 1979	155	BCNRS
103 J/1,2, 7-10	Chatham Sound	13 Sep 1979	119	MWFI*
	Chatham Sound	19 Jan 1978	103	MWFI**
103 J/2	Triple Island to Bell Passage	30 Jun 1976	113	BCNRS
103 J/7	Lucy Islands	7 Jul 1987	107	BCNRS
103 K/2,3	Cape Knox to Masset Harbour	23 Sep 1977	112	Savard*
	Cape Knox to Masset Harbour	9 Jan 1978	151	Savard*
	Cape Knox to Masset Harbour	13 Feb 1978	166	Savard*

1 *= Aerial Survey
**= Boat Survey
MWFI= Mid-Winter Flight Inventory
BCNRS= British Columbia Nest Record Scheme
Savard= Savard 1978a,b,d,e